Fisher® 4194A, B, and C Differential Pressure Controllers

Contents

1. Introduction
- Scope of Manual 3
- Description 5
- Specifications 5
- Educational Services 5

2. Installation
- Controller Mounting Orientation 7
- Pipestand Mounting 8
- Panel Mounting 8
- Wall Mounting 9
- Actuator Mounting 9
- Pressure Connections 10
  - Process Pressure Connections 10
  - Supply Pressure Connection 10
  - Remote Set Point (suffix letter M) Pressure Connection 10
- Vent 11

3. 4194A Proportional-Only Controllers
- Adjustments for 4194A Controllers 12
  - Manual Set Point Adjustment 12
  - Remote Set Point (suffix letter M) Adjustment 13
  - Proportional Band Adjustment (PB ADJ) 13
  - Changing Controller Action 13
  - Switching the Auto/Manual Station (suffix letter E) 14
- Prestartup Checks for 4194A Controllers 14
- Startup for 4194A Controllers 15
- Calibration of 4194A Controllers 16
  - General Calibration Instructions 16
  - Process Indicator Zero and Span Calibration 16
  - Remote Set Point (suffix letter M) Zero and Span Calibration 17
  - Flapper Alignment 18
- Principle of Operation for 4194A Controllers 20
  - Overall Operation 20
  - Remote Set Point (suffix letter M) Operation 21
  - Auto/Manual Station (suffix letter E) Operation 21

4. 4194B Proportional-Plus-Reset Controllers and 4194C Proportional-Plus-Reset-Plus-Rate Controllers
- Adjustments for 4194B and C Controllers 22
  - Manual Set Point Adjustment 22
  - Remote Set Point (suffix letter M) Adjustment 24
  - Proportional Band Adjustment (PB ADJ) 24
  - Changing Controller Action 24
  - Reset Adjustment 25
  - Rate Adjustment 25
  - Anti-Reset Windup (suffix letter F) Adjustment 25
  - Switching The Auto/Manual Station (suffix letter E) 25
- Prestartup Checks for 4194B and C Controllers . . 26
- Startup for 4194B and C Controllers 26
- Calibration of 4194B and C Controllers 28
  - General Calibration Instructions 28
  - Process Indicator Zero and Span Calibration 28
  - Remote Set Point (suffix letter M) Zero and Span Calibration 29
  - Flapper Alignment 30
  - Anti-Reset Windup Differential Relief Valve Calibration 32
- Principle of Operation for 4194B and C Controllers 33
  - Overall Operation 33
  - Anti-Reset Windup (suffix letter F) Operation 36
  - Remote Set Point (suffix letter M) Operation 36
  - Auto/Manual Station (suffix letter E) Operation 37

5. Maintenance
- Inspection and Maintenance 38
- Troubleshooting 38
- Replacing Common Controller Parts 42
  - Replacing the Process Pressure Scale 42
  - Replacing the Relay 43
  - Replacing the Case and Cover 43
  - Replacing the Gauges 44
  - Replacing the Pressure Control Block 44
  - Replacing the Supply Gauge, Proportional, Reset, and Reset Valve Tubing Assemblies 45

Replacing the Proportional Band Adjustment Knob, Nozzle Assembly, and Set Point Beam Assembly 45
Replacing the Flapper Assembly and Flapper Flexure Pivot Assembly 50
Replacing the Proportional or Reset Bellows 54
Replacing the Reset Restriction Valve (4194B Controllers) 57
Replacing the Rate/Reset Valve Assembly (4194C Controllers) 57
Replacing the Anti-Reset Windup (suffix letter F) Differential Relief Valve . . . 58
Replacing the Anti-Reset Windup (suffix letter F) Relief Valve Tubing Assembly 58
Replacing the Links 59
Replacing Link 1 59
Replacing Link 2 60
Replacing Link 3 61
Replacing Link 4 62
Replacing Link 5 63
Replacing the Capsular Element Assembly 63
Replacing the Long Pivot Assembly 64
Replacing the Short Pivot Assembly 65
Replacing the Process Drive Flexure 66
Replacing the Process Tubing 67
Capsular Element Maintenance Calibration 67
Precalibration Procedures 67
Aligning the Drive Bracket Assembly 67
Setting the Travel Stops 68
Aligning the Linkage 68
Zero and Span Adjustment 69
Remote Set Point (suffix letter M) Maintenance 72
Replacing the Remote Set Point Assembly 72
Replacing Remote Set Point Assembly Parts 72
Replacing Pivot Assembly A (key 114) 73
Replacing Pivot Assembly B (key 115) 74
Replacing the Drive Flexure 74
Replacing the Remote Set Point Tubing 75
Replacing Link A 75
Replacing Link B 75
Remote Set Point (suffix letter M) Maintenance Calibration 76
Precalibration Procedures 76
Aligning the Flexures 76
Setting the Travel Stops 77
Aligning the Linkage 77
Remote Set Point Zero and Span Adjustment 78
Remote Set Point Linearity Adjustment 79
Auto/Manual Station (suffix letter E) Maintenance 79
Replacing the Auto/Manual Station 79
Replacing the Switch Body Assembly, Lever O-ring, Switch Body O-ring and Tubing Assembly 80
Replacing the Loader Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball 81
Replacing the Loader Valve Plug and Valve Plug Spring 82
6. Parts
Parts Ordering 84
Parts Kits 84
Parts List 84
Abbreviations Used in the Parts List 84
Controller Common Parts 85
Process and Set Point Indicator Assembly 91
Capsular Element Assembly 92
Indicator Assembly 94
Remote Set Point Assembly (suffix letter M) 94
Auto/Manual Station (suffix letter E) 96
Controller Mounting Parts 98
Pipestand Mounting 98
Pipestand Mounting with Regulator 98
Panel Mounting 98
Wall Mounting 98
Controller Mounting Parts for Actuator With Casing-Mounted Controller 98
Controller Mounting Parts for Actuator With Yoke-Mounted Controller 98
Regulator Mounting Parts 98
Regulator Mounting Parts for Casing-Mounted Regulator 98
Regulator Mounting Parts for Yoke-Mounted Regulator (Mounting Bracket Not Required) 99
Regulator Mounting Parts for Yoke-Mounted Regulator (With Mounting Bracket) 99
Fittings 99

Section 1

Introduction

Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information for 4194A, 4194B and 4194C differential pressure indicating controllers.

Portions of this manual apply only to specific configurations in the 4194 controller configurations. These configurations are indicated by letter suffixes in the type number that correspond to the mode and option designated in table 1-2.

The specific controller type number (with letter suffixes) is located on the nameplate shown in figure 1-1. Refer to table 1-2 for the definition of each 4194 controller type number.

Figure 1-1. Fisher 4194 Differential Pressure Controllers

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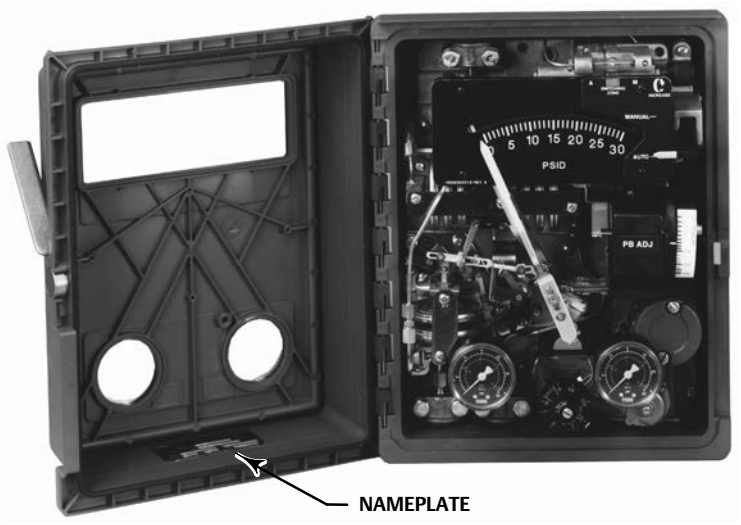

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Do not install, operate, or maintain a 4194A, B, or C controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Table 1-1. Specifications

Available Configurations

See table 1-2

Input Signal (Differential Pressure Sensing Element Range)

Lower and Upper Range Limits: As shown in table 1-3

Maximum Allowable Pressure: As shown in table 1-3

Output Signal

Proportional-Only, Proportional-Plus-Reset, or Proportional-Plus-Reset-Plus-Rate Range: 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.0 bar (6 to 30 psig)
Action: Field-reversible between direct (increasing differential pressure increases output pressure) or reverse (increasing differential pressure decreases output pressure)

Process Scale

Standard scale is matched to the range of the differential pressure sensing element. Linear, square root, and optional(1) scales available

Process Connections

Standard: 1/4 NPT internal stainless steel (all input ranges); also available, steel or stainless steel reducing adapters that permit 1/2 inch external or internal connections
Optional: 1/2 NPT external stainless steel

Supply and Output Connections

1/4 NPT internal

Supply Pressure Requirements(2)

See table 1-4

Supply Pressure Medium

Air or natural gas

Air: Supply pressure must be clean, dry air that meets the requirements of ISA Standard 7.0.01.

Natural Gas: Natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

Remote Set Point Pressures

0.2 to 1.0 bar (3 to 15 psig) or
0.4 to 2.0 bar (6 to 30 psig)

Controller Adjustments

Proportional Band: 5 to 500% of process scale range
Reset: Adjustable from 0.01 to more than 74 min per repeat (from 100 to less than 0.0135 repeats per min)
Rate: Adjustable from 0 to 20 minutes
Set Point: Adjustable from 0 to 100% of the scale range

Controller Performance

Repeatability: 0.4% of output span
Dead Band: Less than 0.4% of process scale span
Typical Frequency Response: 1.5 Hz and 90 deg phase shift with 3.05 m (10 ft) of 6.4 mm (1/4 inch) tubing and 1639 cm^3 (100 cubic inch) volume

Steady-State Air Consumption(3)

Without Auto/Manual Station
0.2 to 1.0 Bar (3 to 15 Psig) Output:
0.09 m^3/hr (3.5 scfh)
0.4 to 2.0 Bar (6 to 30 Psig) Output:
0.13 m^3/hr (5.0 scfh)

With Auto/Manual Station (suffix letter E)
0.2 to 1.0 Bar (3 to 15 Psig) Output:
0.28 m^3/hr (10.0 scfh)
0.4 to 2.0 Bar (6 to 30 Psig) Output:
0.28 m^3/hr (10.0 scfh)

Delivery Capacity(3)

0.2 to 1.0 Bar (3 to 15 Psig) Output:
6.4 m^3/hr (240 scfh)
0.4 to 2.0 Bar (6 to 30 Psig) Output:
9.4 m^3/hr (350 scfh)

Exhaust Capacity(3)

0.2 to 1.0 Bar (3 to 15 Psig) Output:
4.6 m^3/hr (186 scfh)
0.4 to 2.0 Bar (6 to 30 Psig) Output:
7.9 m^3/hr (295 scfh)

-continued-

Table 1-1. Specifications (continued)

Operative Ambient Temperature Limits(2)

-40 to 70°C (-40 to 160°F)

Hazardous Area Classification

Complies with the requirements of ATEX Group II Category 2 Gas and Dust

CE ⟨Ex⟩ II 2 G D

Housing

Designed to NEMA 3 (Weatherproof) and IEC 529 IP54 specifications

Mounting

Controller can be mounted on actuator, panel, wall, or pipestand

Approximate Weight

4.5 kg (10 lb)

Declaration of SEP

Fisher Controls International LLC declares this product to be in compliance with Article 3 paragraph 3 of the Pressure Equipment Directive (PED) 97 / 23 / EC. It was designed and manufactured in accordance with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance.

However, the product *may* bear the CE marking to indicate compliance with *other* applicable European Community Directives.

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. Consult your Emerson Process Management sales office for additional information
2. The pressure/temperature limits in this document and any applicable standard or code limitation should not be exceeded.
3. Normal m^3/hr—Normal cubic meters per hour (0°C and 1.01325 bar, absolute). Scfh—Standard cubic feet per hour (60°F and 14.7 psia).

Description

The controllers described in this manual provide differential pressure control with options as shown in table 1-2.

- 4194A controllers: Proportional-only control
- 4194B controllers: Proportional-plus-reset control
- 4194C controllers: Proportional-plus-reset-plus-rate control

These controllers show process differential pressure and set point on an easy-to-read process scale. The controller output is a pneumatic signal that operates a final control element.

Specifications

Specifications for 4194A, B, and C controllers are listed in table 1-1.

Educational Services

For information on available courses for 4194A, B, and C differential pressure controllers, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
Phone: +1-641-754-3771 or +1-800-338-8158
e-mail: education@emerson.com
http://www.emersonprocess.com/education

Table 1-2. Available Configurations for Fisher 4194A, 4194B, and 4194C Controllers

SERIES	CONTROLLER(1)	MODES			OPTIONS		
		Proportional-Only (One-Mode Controllers)	Proportional-Plus-Reset (Two-Mode Controllers)	Proportional-Plus-Reset-Plus-Rate (Three-Mode Controllers)	Internal Auto/Manual Station (suffix letter E)	Anti-Reset Windup (suffix letter F)	Remote Set point (suffix letter M)
4194A	4194A	X	---	---	---	---	---
	4194AE	X	---	---	X	---	---
	4194AM	X	---	---	---	---	X
	4194AME	X	---	---	X	---	X
4194B	4194B	---	X	---	---	---	---
	4194BE	---	X	---	X	---	---
	4194BF	---	X	---	---	X	---
	4194BFE	---	X	---	X	X	---
	4194BM	---	X	---	---	---	X
	4194BME	---	X	---	X	---	X
	4194BFM	---	X	---	---	X	X
	4194BFME	---	X	---	X	X	X
4194C	4194C	---	---	X	---	---	---
	4194CE	---	---	X	X	---	---
	4194CF	---	---	X	---	X	---
	4194CFE	---	---	X	X	X	---
	4194CM	---	---	X	---	---	X
	4194CME	---	---	X	X	---	X
	4194CFM	---	---	X	---	X	X
	4194CFME	---	---	X	X	X	X

1. Reverse-acting constructions are designated by the suffix letter R added to the type number.

Table 1-3. Process Sensor (Capsular Element) Pressure Ratings and Material

UNITS	CAPSULAR ELEMENT RANGES	DIFFERENTIAL SPAN		STATIC PRESSURE OPERATING RANGE(3)		OPERATING LIMITS(4)	STANDARD MATERIAL
		Minimum(1)	Maximum(2)	Minimum Inches of Mercury	Maximum		
Metric Units	0 to 350 mbar 0 to 0.7 bar 0 to 1.4 bar 0 to 2.0 bar	175 mbar 0.4 bar 0.7 bar 1.0 bar	350 mbar 0.7 bar 1.4 bar 2.0 bar	-350 mbar -0.7 bar -1.0 bar -1.0 bar	455 mbar 0.9 bar 1.8 bar 2.7 bar	500 mbar 1.0 bar 2.1 bar 3.1 bar	N09902
U. S. Units	0 to 5 psid 0 to 10 psid 0 to 20 psid 0 to 30 psid	2.5 psid 5.0 psid 10.0 psid 15.0 psid	5 psid 10 psid 20 psid 30 psid	-10 -20 -30 -30	6.5 psig 13.5 psig 27.0 psig 40.5 psig	7.5 psig 15.0 psig 30.0 psig 45.0 psig	

1. Span is adjustable between minimum shown and maximum of the capsular element operating range and can be positioned any where within this range. For example, if a 0 to 2.0 bar (0 to 30 psid) capsular element is used with a minimum span of 1.0 bar (15 psid), 1.0 to 2.0 bar (15 to 30 psid), or any value between the minimum and maximum values of the operating range is possible.
2. Maximum difference between the two input supply pressures.
3. Capsular element may be pressured to this value without permanent zero shift or structural damage to controller components.
4. With travel stops set, capsular element may be pressured to this value without permanent zero shift or structural damage to controller components.

Table 1-4. Supply Pressure Data

Output Signal Range		Normal Operating Supply Pressure(1)	Maximum Pressure to Prevent Internal Part Damage(2)
Metric Units	0.2 to 1.0 bar 0.4 to 2.0 bar	1.4 bar 2.4 bar	2.8 bar 2.8 bar
U.S. Units	3 to 15 psig 6 to 30 psig	20 psig 35 psig	40 psig 40 psig

1. If the pressure is exceeded, control stability may be impaired.
2. If the pressure is exceeded, damage to the controller may result.

Section 2

Installation

⚠ WARNING

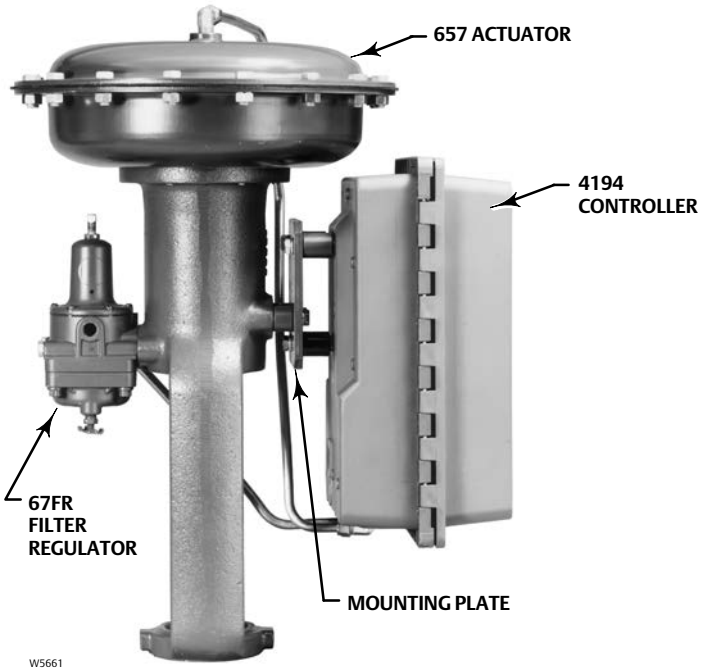
To avoid personal injury or property damage resulting from the sudden release of pressure:

- **Always wear protective clothing, gloves, and eyewear when performing any installation operations.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 11.**
- **If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section of this instruction manual.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Controller Mounting Orientation

Mount the controller with the housing vertical, as shown in figure 2-1, so that the vent points down.

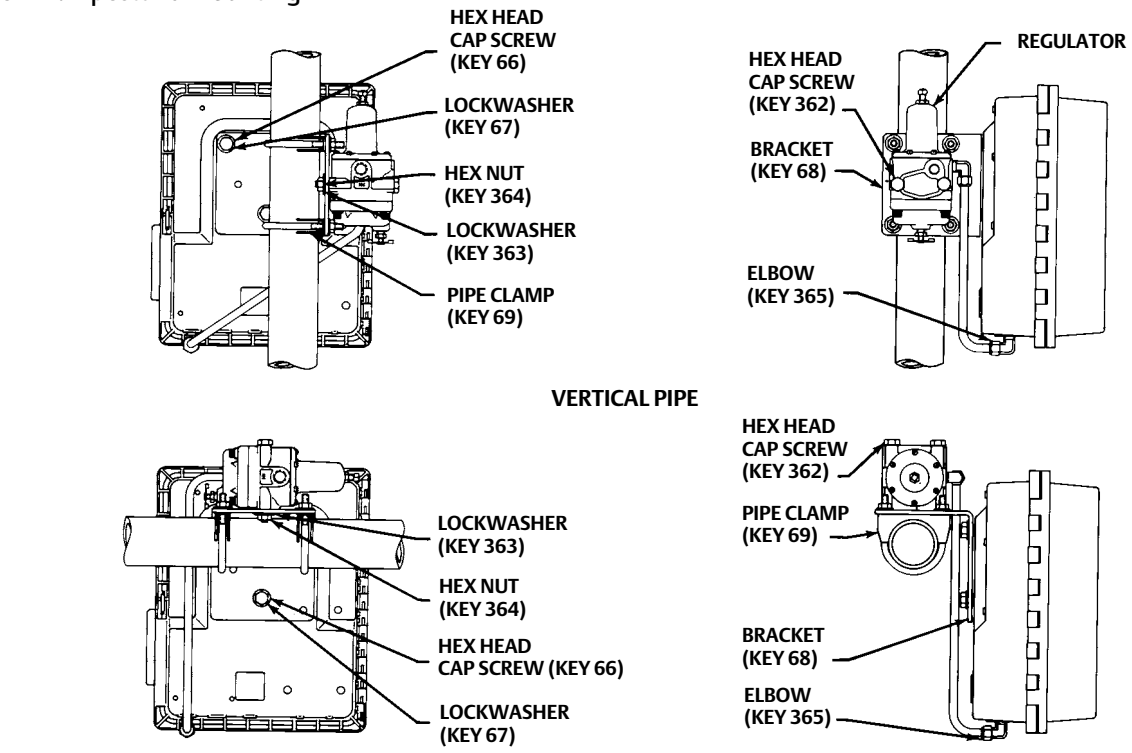
Figure 2-1. Typical Actuator Mounting



Pipestand Mounting

Refer to figure 2-2. Pipestand mounting parts are provided to mount the controller to a 2-inch (nominal) pipe. Attach a bracket (key 68) to the controller with cap screws (key 66) and lock washers (key 67). Attach two clamps (key 69) to the bracket, and fasten the controller to the pipe.

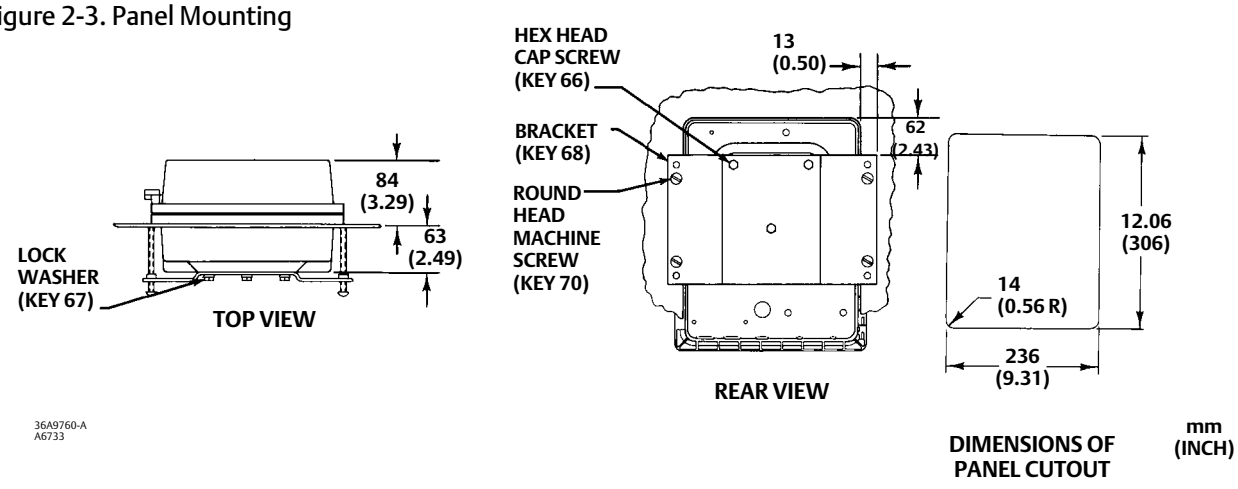
Figure 2-2. Pipestand Mounting



Panel Mounting

Using the dimensions shown in figure 2-3, cut a hole in the panel surface. Slide the controller into the hole and attach the bracket (key 68) to the rear of the controller using three cap screws (key 66) and lock washers (key 67). Tighten the screws (key 70) to seat the case snugly and evenly against the panel surface.

Figure 2-3. Panel Mounting

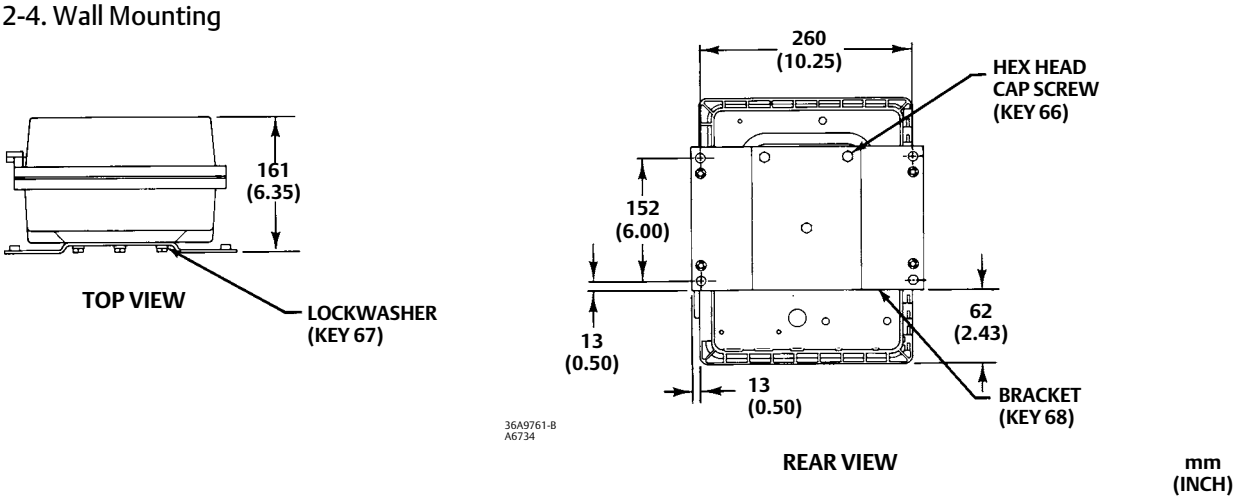


Wall Mounting

Using the dimensions in figure 2-4, drill holes in the wall to align with the four holes in the bracket (key 68). If the tubing is to run through the wall, drill a hole in the wall large enough to accept the tubing.

Mount the controller to the bracket using three cap screws (key 66) and lock washers (key 67). Attach the bracket to the wall, using suitable screws or bolts.

Figure 2-4. Wall Mounting



Actuator Mounting

Refer to figure 2-1. A controller specified for mounting on a control valve actuator is mounted at the factory. If the controller is ordered separately for installation on a control valve actuator, mount the unit as described in this section. Mounting parts vary for different actuator types.

Attach the mounting bracket to the actuator yoke with cap screws, lock washers, and spacer spools. Attach the controller to the bracket with cap screws, lock washers, and spacer spools. On some designs, the mounting bracket is attached to the actuator casing rather than to the yoke.

Pressure Connections

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component where service conditions could exceed the limits given in this manual. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

Refer to figure 2-5 for pressure connection locations. Supply, output, remote set point, and vent connections are 1/4 NPT, internal. Process pressure connections are 1/4 or 1/2 NPT (optional).

Process Pressure Connections

Process pressures are piped to the connections marked A and B on the bottom of the case, shown in figure 2-5. Pipe the high pressure line to connection B and the low pressure line to connection A.

When installing process piping, follow accepted practices to ensure accurate transmission of the process pressure to the controller. Install a three-valve bypass, shutoff valves, vents, drains, or seal systems as needed in the process pressure lines. If necessary, install a needle valve in a process pressure sensing line to dampen pulsations.

If the instrument is located such that the adjacent process pressure lines are approximately horizontal, the lines should slope downward to the instrument for liquid-filled lines and upward toward the instrument for gas-filled lines. This reduces the possibility of air becoming trapped in the sensor with liquid-filled lines or of condensation becoming trapped in gas-filled lines. The recommended slope is 83 millimeters per meter (1 inch per foot).

Supply Pressure Connection

⚠ WARNING

Severe personal injury or property damage may occur if the instrument air supply is not clean, dry, and oil-free, or noncorrosive gas. While use and regular maintenance of a filter that removes particles larger than 40 micrometers in diameter will suffice in most applications, check with an Emerson Process Management field office and industry instrument air quality standards for use with corrosive gas or if you are unsure about the proper amount or method of air filtration or filter maintenance.

Supply pressure must be clean, dry air or noncorrosive gas that meets the requirements of ISA 7.0.01. A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized. Natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

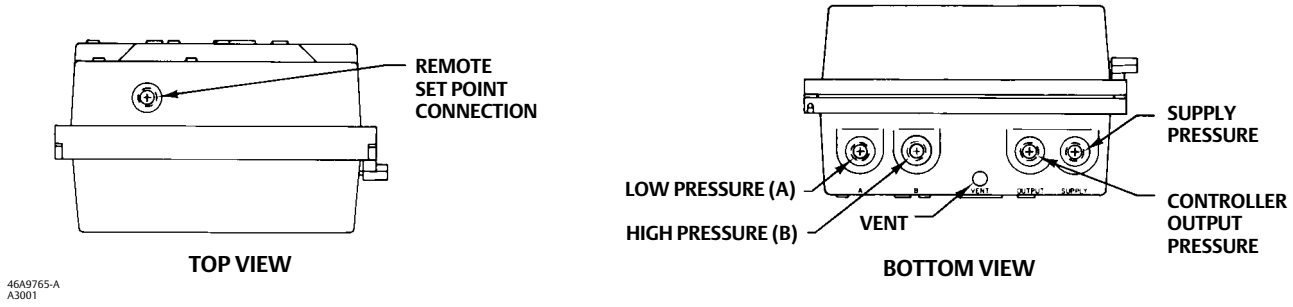
Use a suitable supply pressure regulator to reduce the supply pressure source to the normal operating supply pressure shown in table 1-4. Connect supply pressure to the SUPPLY connection on the bottom of the case, shown in figure 2-5.

Remote Set Point (suffix letter M) Pressure Connection

If the controller has remote set point (suffix letter M), connect the remote set point pressure to the top of the controller case at the location shown in figure 2-5. Use clean dry air or noncorrosive gas. Use a 0.2 to 1.0 bar

(3 to 15 psig) remote set point pressure range for a 0.2 to 1.0 bar (3 to 15 psig) controller output signal range or a 0.4 to 2.0 bar (6 to 30 psig) remote set point pressure range for a 0.4 to 2.0 bar (6 to 30 psig) controller output signal range. If pressure is supplied to the remote set point connection with a regulator, a small bleed orifice should be placed between the regulator and remote set point connection to prevent pressure variations due to regulator lock-up.

Figure 2-5. Location of Connections



Vent

⚠ WARNING

Personal injury or property damage could result from fire or explosion of accumulated gas, or from contact with hazardous gas, if a flammable or hazardous gas is used as the supply pressure medium. Because the instrument case and cover assembly do not form gas tight seal when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used to prevent the accumulation of flammable or hazardous gas. However, a remote vent pipe alone cannot be relied upon to remove all flammable and hazardous gas. Vent line piping should comply with local and regional codes, and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

CAUTION

When installing a remote vent pipe, take care not to over-tighten the pipe in the vent connection. Excessive torque will damage the threads in the connection.

If a remote vent is required, the vent line must be as short as possible with a minimum number of bends and elbows. Vent line piping should have a minimum inside diameter of 19 mm (3/4 inches) for runs up to 6.1 meters (20 feet) and a minimum inside diameter of 25 mm (1 inch) for runs from 6.1 to 30.5 meters (20 to 100 feet).

The vent must be protected against the entrance of any foreign material that could plug it; or, if a remote vent is not required, the vent opening in the case must be protected against the entrance of any foreign material that could plug it. Check the vent periodically to be certain it is not plugged.

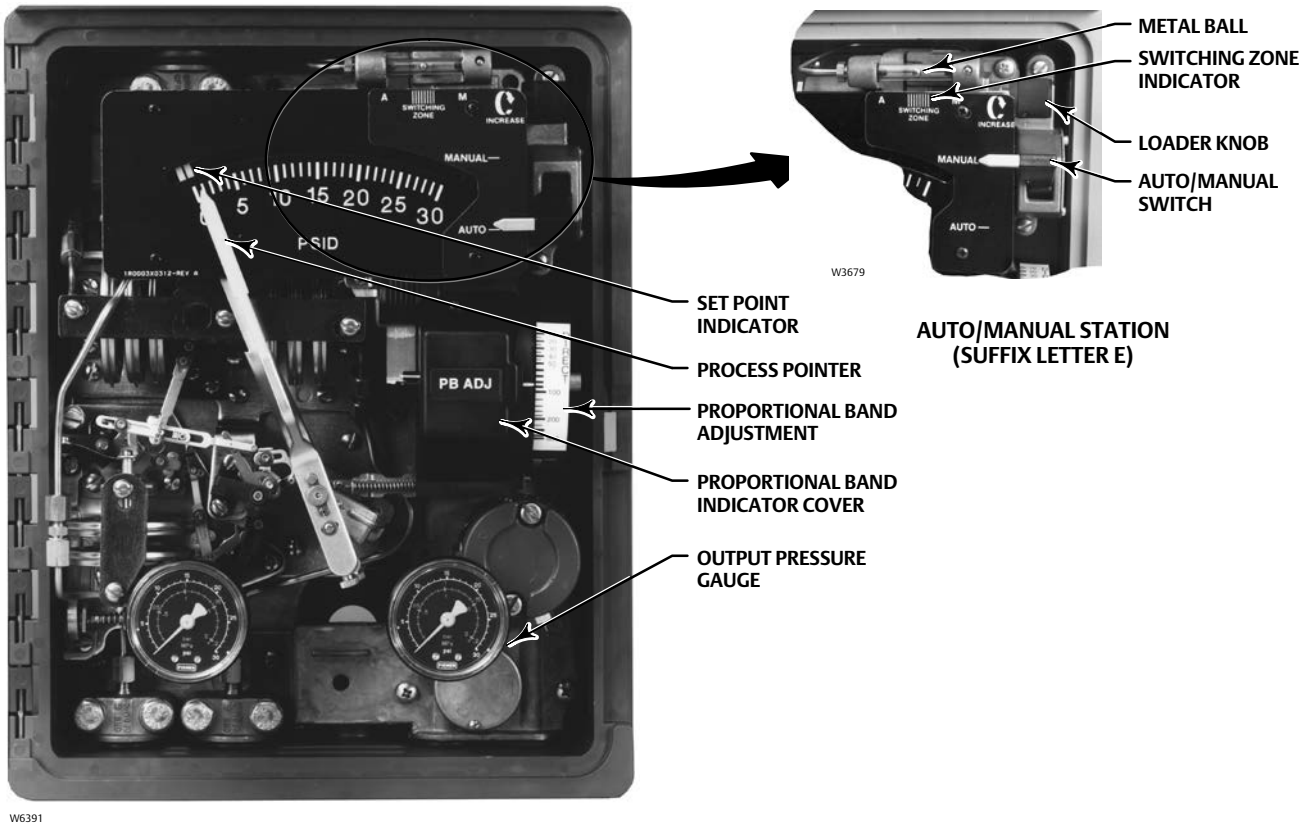
Section 3

4194A Proportional-Only Controllers

Adjustments for 4194A Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup, and calibration. Adjustment locations are shown in figures 3-1 and 3-3. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 3-4 and 3-5. Unless otherwise noted, key numbers given in this section are found in figure 6-1.

Figure 3-1. Fisher 4194A Controller Adjustment Locations



Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process differential pressure scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

CAUTION

Do not manually move the set point indicator on controllers with remote set point. Manually moving the set point indicator could damage the controller.

If the controller is equipped with remote set point (suffix letter M), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point, and decrease the pressure to decrease the set point.

Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process differential pressure required to drive the controller from zero output to full output.

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 3-2 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

Figure 3-2. Changing Controller Action (Fisher 4194A Controllers)

W3439

For direct control action:

An increasing sensed differential pressure increases output pressure.

For reverse control action:

An increasing sensed differential pressure decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

Switching the Auto/Manual Station (suffix letter E)

Note

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 3-1 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

When the auto/manual switch is in AUTO, adjusting the loader knob has no effect on the controller output. When the auto/manual switch is in MANUAL, changing the set point has no effect on the controller output.

Prestartup Checks for 4194A Controllers

Refer to figure 3-1 for adjustment locations and refer to figure 6-1 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks.

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.1 bar (6 to 30 psig) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.

5. Adjust the proportional band for 5 percent DIRECT.
6. If necessary, connect a pressure source to the process connection and adjust the process pointer to the last mark on the left side of the scale. If the last scale mark is 0 psig, a pressure source is not required.
7. The controller output pressure should be 0 psig.
8. Rotate the proportional band to 5 percent REVERSE.
9. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
10. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4194A controller calibration procedure for recalibration.

Startup for 4194A Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. For controllers with:

Manual set point:

Move the set point indicator to the desired set point.

Remote set point:

a. See figure 2-5 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.

3. Set the proportional band adjustment to 100 percent for fast processes. For slow processes, calculate the proportional band percentage from the equation below:

$$\text{Proportional Band Adjustment} = \frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}}$$

For example:

$$\frac{200 \times 2 \text{ Psig}}{30 \text{ Psig}} \cong 13\%$$

4. Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting x 2).

5. Check the stability of the recommended proportional band setting by introducing a disturbance and monitoring the process.

Calibration of 4194A Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing calibration.

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are found in figure 6-1.

Do not use the gauges supplied with the controller during calibration. Monitor process pressure, supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a regulated process differential pressure to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note

Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.

Refer to figures 3-1 and 3-3 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply process differential pressure equal to the process scale span lower limit.

4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Apply process differential pressure equal to the process scale span upper limit.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply process differential pressure equal to the mid-scale value of the process scale span. The process pointer should indicate the mid-scale mark, ±2 percent of span. If the error is greater than ±2 percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the locking screw and turning the zero adjustment screw. This distributes the error over the entire scale span and brings all points within ±1 percent of the process scale span.
10. Apply process differential pressure equal to the process scale span lower limit.
11. The process pointer should indicate the process scale lower limit ±1 percent of the scale span.
12. Apply process pressure equal to the process scale span upper limit.
13. The process pointer should indicate the process scale upper limit ±1 percent of the process scale span.
14. If the error is greater than ±1 percent, repeat steps 3 through 13.

Remote Set Point (suffix letter M) Zero and Span Calibration

Refer to figures 3-1 and 3-3 for adjustment locations. Refer to figures 6-1 and 6-5 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply remote set point pressure equal to the mid-range value.
9. Make sure the set point indicator is within ±1 percent of the mid-scale mark and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within ±2 percent of the mid-scale mark, then proceed with step 10. If the set point indicator is not within ±2 percent, proceed to the remote set point calibration procedure in the Maintenance section.

10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid-scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within ±1 percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

Flapper Alignment

Note

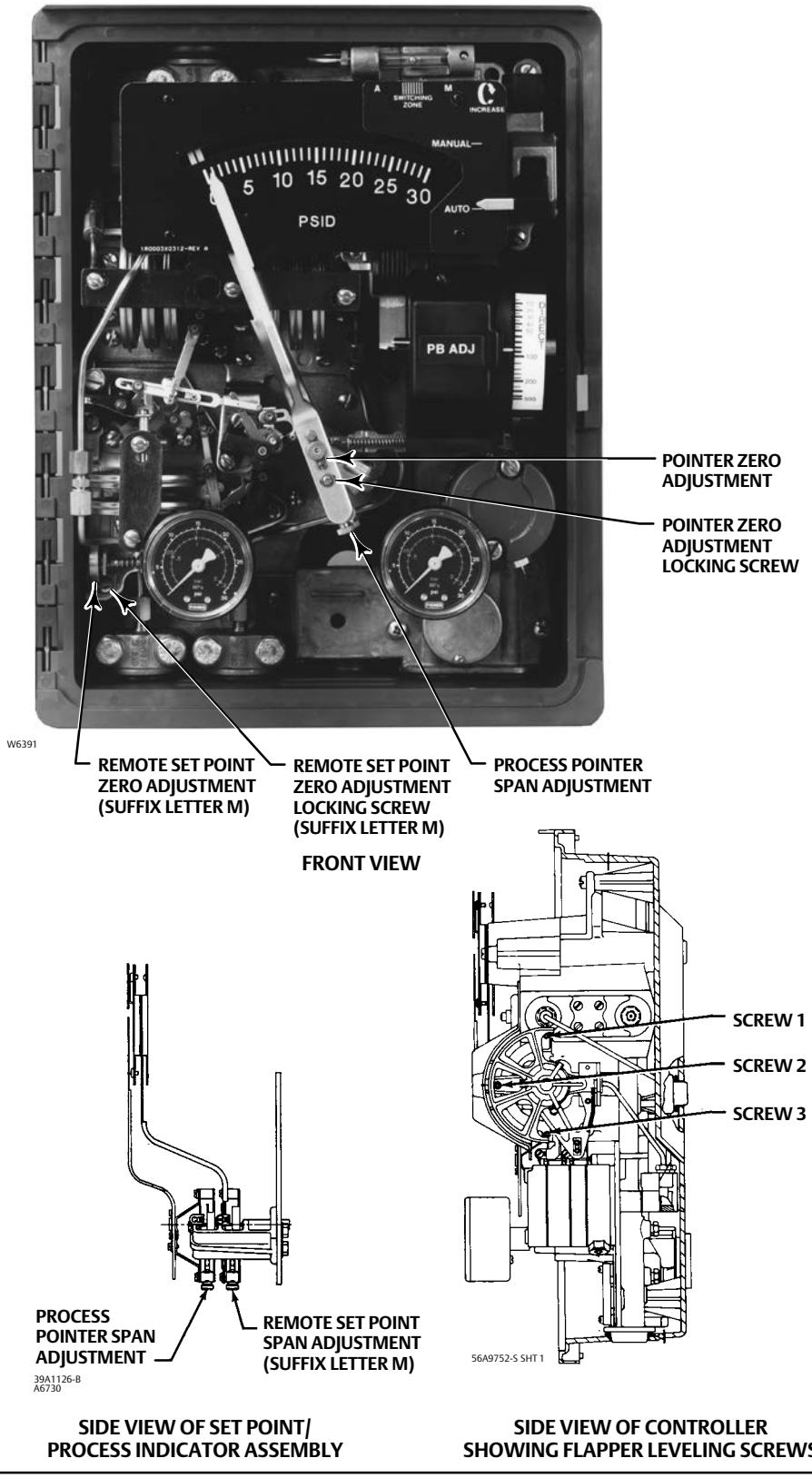
Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 3-3. Key number locations are shown in figure 6-1.

Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4. After performing the flapper alignment procedure, go to the startup procedure.

1. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at the mid-scale on the process scale.
2. Apply process differential pressure equal to the mid-scale value of the process scale span. If pressure is not available to pressure the input element to the mid-scale value, an alternate method is to disconnect link number 1 at the input element and tape the process pointer at the mid-scale mark of the process scale. Note the hole from which link number 1 was removed for proper replacement. This method should only be used if pressure is not available to pressure the input element to the mid-scale value.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Set the proportional band between DIRECT and REVERSE.
5. The controller output should be 0.62 ±0.007 bar (9 ±0.10 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 1.2 ±0.01 bar (18 ±0.2 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is within tolerance.
6. Set the proportional band to 30 percent DIRECT.
7. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw 3 (the screw nearest the nozzle).
8. Set the proportional band to 30 percent REVERSE.
9. The controller output should be 0.62 ±0.02 bar (9 ±0.25 psig) or 1.2 ±0.04 bar (18 ±0.5 psig). If not, adjust flapper leveling screw 1 (the screw nearest the nozzle).
10. Repeat steps 4 through 9 until the controller output remains in tolerance without further leveling screw adjustment.
11. If link 1 was disconnected, remove the tape and reconnect link 1 to the input element.
12. Set the proportional band to 400 percent in the desired controller action and replace the proportional band indicator cover.

Figure 3-3. Fisher 4194A Controller Calibration Adjustment Locations



Principle of Operation for 4194A Controllers

Overall Operation

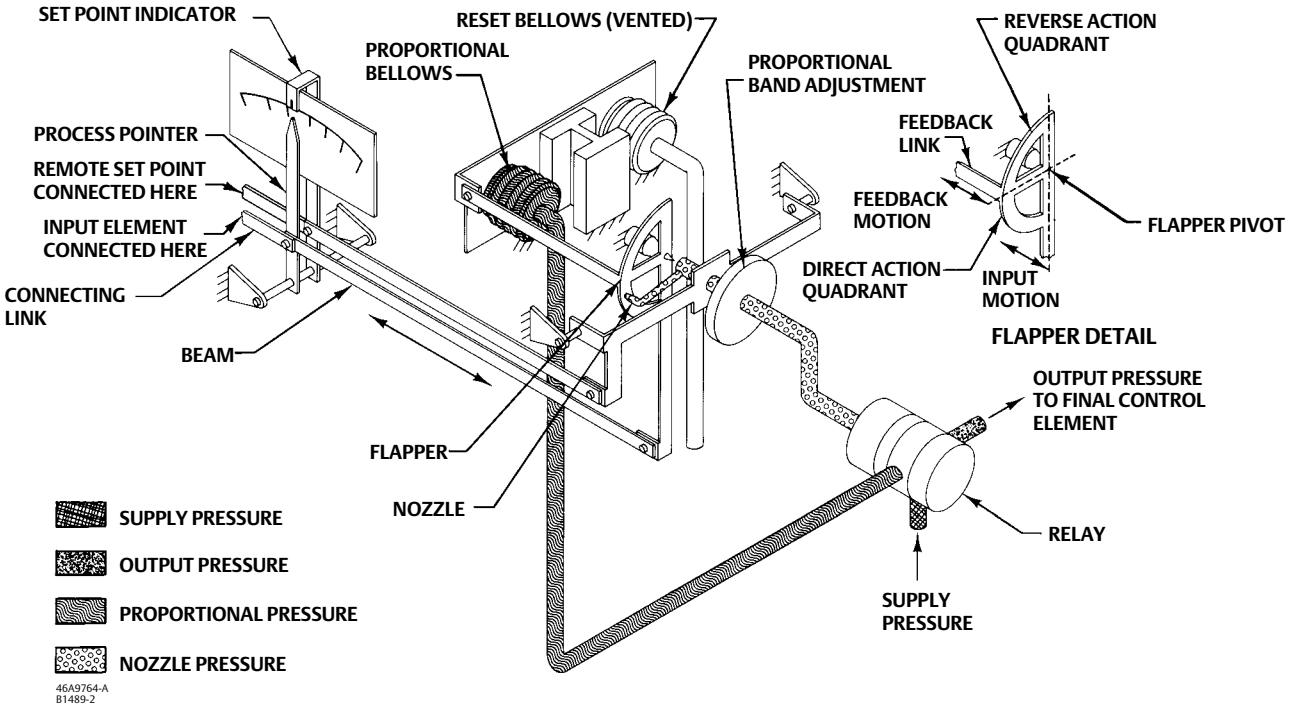
Refer to the schematic diagram in figure 3-4.

The input element is connected to the process pointer and to the flapper by connecting links. As the process differential pressure increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows. The action of the proportional bellows counteracts the flapper movement that resulted from the process differential pressure change and backs the flapper away from the nozzle until equilibrium is reached.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process pressure, except that when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 3-4. With the controller in the reverse-acting mode, an increase in process differential pressure causes a decrease in output pressure.

Figure 3-4. Fisher 4194A Controller Schematic



Remote Set Point (suffix letter M) Operation

The capability to adjust the controller set point from a remote location is available with all 4194A controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

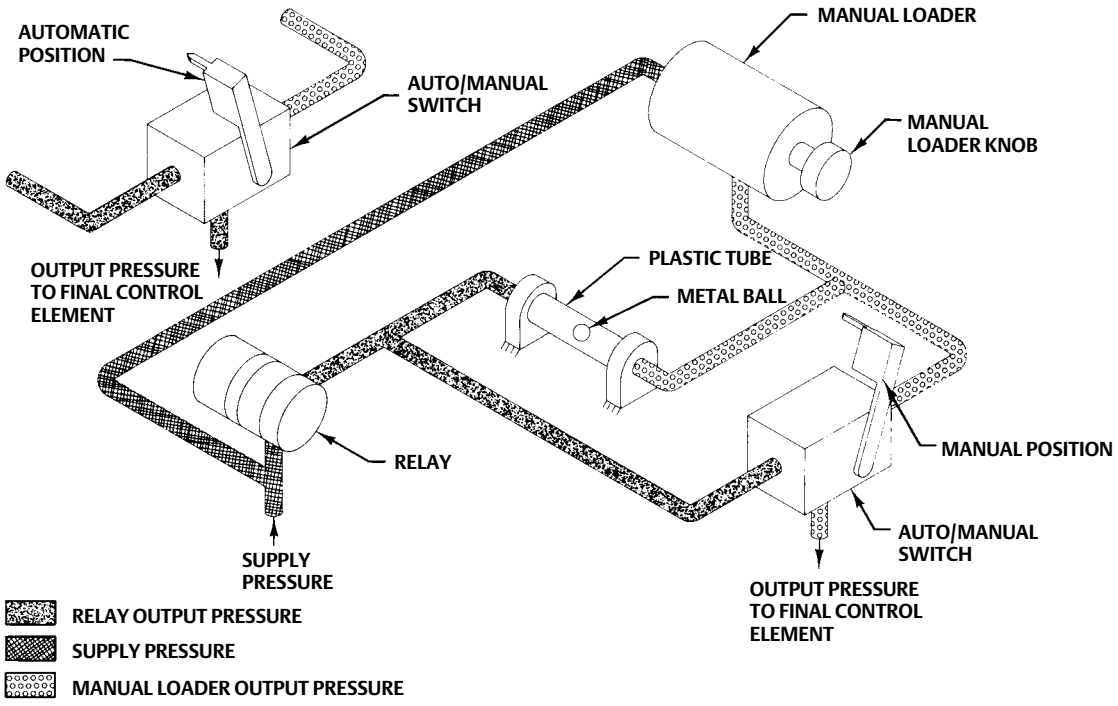
Auto/Manual Station (suffix letter E) Operation

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 3-5. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the manual loader output is channeled through the auto/manual switch and becomes the controller output. When the auto/manual switch is in the AUTO position, the relay output is channeled through the switch to become the controller output.

Before the auto/manual switch is operated, the relay output must equal the manual loader output to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Figure 3-5. Fisher 4194A Auto/Manual Station Schematic



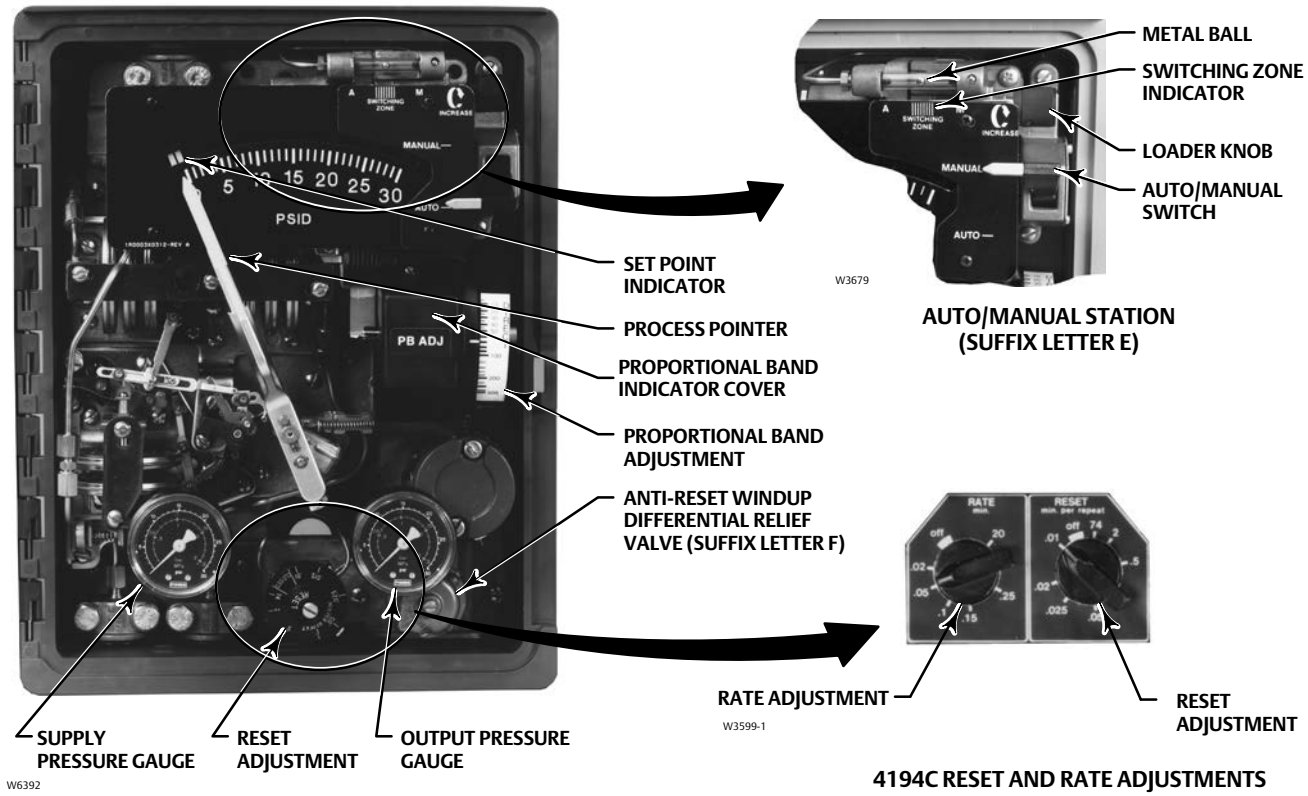
Section 4

4194B Proportional- Plus-Reset Controllers and 4194C Proportional- Plus-Reset-Plus-Rate Controllers

Adjustments for 4194B and C Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup and calibration. Adjustment locations are shown in figures 4-1 and 4-2. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 4-5, 4-6, 4-7 and 4-8. Unless otherwise noted, key numbers given in this section are found in figure 6-1.

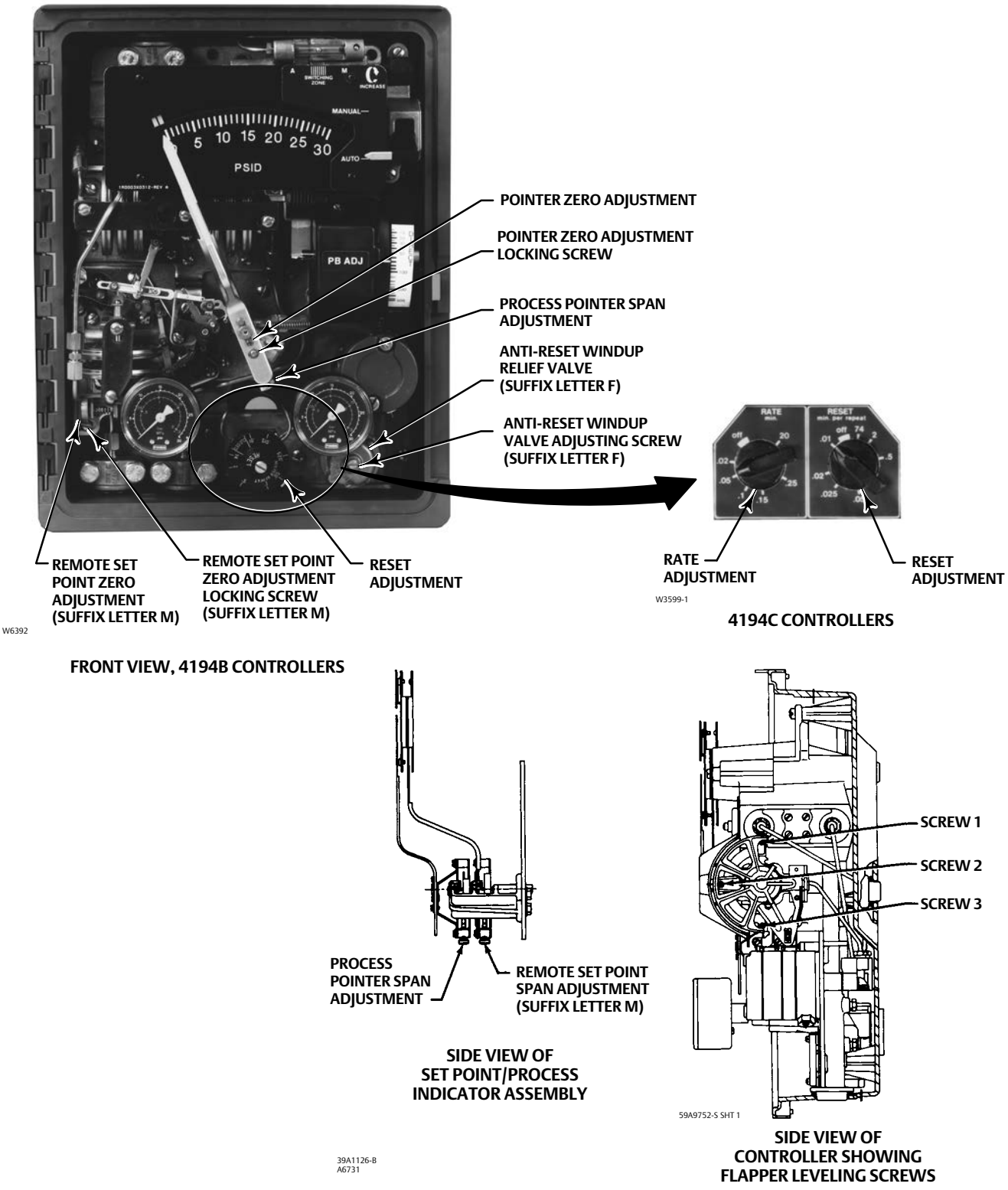
Figure 4-1. Fisher 4194B and C Controller Adjustment Locations



Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process differential pressure scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

Figure 4-2. Fisher 4194B and C Controller Calibration Adjustment Locations


POINTER ZERO ADJUSTMENT
POINTER ZERO ADJUSTMENT LOCKING SCREW
PROCESS POINTER SPAN ADJUSTMENT
ANTI-RESET WINDUP RELIEF VALVE (SUFFIX LETTER F)
ANTI-RESET WINDUP VALVE ADJUSTING SCREW (SUFFIX LETTER F)
REMOTE SET POINT ZERO ADJUSTMENT (SUFFIX LETTER M)
REMOTE SET POINT ZERO ADJUSTMENT LOCKING SCREW (SUFFIX LETTER M)
RESET ADJUSTMENT
W6392
FRONT VIEW, 4194B CONTROLLERS
RATE ADJUSTMENT
RESET ADJUSTMENT
W3599-1
4194C CONTROLLERS
PROCESS POINTER SPAN ADJUSTMENT
REMOTE SET POINT SPAN ADJUSTMENT (SUFFIX LETTER M)
SIDE VIEW OF SET POINT/PROCESS INDICATOR ASSEMBLY
39A1126-B
A6731
SCREW 1
SCREW 2
SCREW 3
59A9752-S SHT 1
SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point and counterclockwise to decrease the process set point.

Remote Set Point (suffix letter M) Adjustment

CAUTION

Do not manually move the set point indicator on controllers with remote set point. Manually moving the set point indicator could damage the controller.

If the controller is equipped with remote set point (suffix letter M), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point, and decrease the pressure to decrease the set point.

Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process differential pressure required to drive the controller from zero output to full output.

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 4-3 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

Figure 4-3. Changing Controller Action (Fisher 4194B and C Controllers)

W3439

For direct control action:

An increasing sensed differential pressure increases output pressure.

For reverse control action:

An increasing sensed differential pressure decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

Reset Adjustment

To adjust reset, open the controller cover and locate the RESET adjustment. Rotate the adjustment clockwise to decrease the minutes per repeat or counterclockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

Rate Adjustment

To adjust rate, open the controller cover and locate the RATE adjustment. Rotate the adjustment clockwise to decrease the minutes (less rate action) or counterclockwise to increase the minutes (more rate action).

Anti-Reset Windup (suffix letter F) Adjustment

If the arrow on the differential relief valve points toward the bottom of the controller case, as shown in figure 4-1, the relief valve opens with increasing controller output pressure. If the arrow points in the opposite direction, the relief valve opens with decreasing controller output pressure. Differential relief pressure is factory set at 0.3 bar (5 psig). Maximum relief pressure is 0.5 bar (7 psig); minimum is 0.1 bar (2 psig).

Turn the adjusting screw counterclockwise to increase differential relief pressure, clockwise to decrease it.

Switching The Auto/Manual Station (suffix letter E)

Note

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 4-1 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

When the automatic/manual switch is in AUTO, adjusting the loader knob has no effect on the controller output. When the automatic/manual switch is in MANUAL, changing the set point has no effect on the controller output.

Prestartup Checks for 4194B and C Controllers

Refer to figure 4-1 for adjustment locations and refer to figure 6-1 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks.

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 0.2 to 1.0 bar (3 to 15 psig) or 0.4 to 2.1 bar (6 to 30 psig) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.
5. Turn the reset adjustment to 0.01 minutes per repeat.
6. Turn the rate adjustment to OFF (4194C).
7. Adjust the proportional band for 5 percent DIRECT.
8. If necessary, connect a pressure source to the process connection and adjust the process pointer to the last mark on the left side of the scale. If the last scale mark is 0 psig, a pressure source is not required.
9. The controller output pressure should be 0 psig.
10. Rotate the proportional band to 5 percent REVERSE.
11. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
12. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action. Secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4194B and C calibration procedure for recalibration.

Startup for 4194B and C Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

Note

When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.

2. For controllers with:

Manual set point:

Move the set point indicator to the desired set point.

Remote set point:

a. See figure 2-5 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.

3. Set the reset adjustment to 0.05 minutes per repeat for fast processes. Set it to 0.5 minutes per repeat for slow processes. For controllers with rate, set the rate adjustment to OFF.
4. Set the proportional band adjustment to 100 percent for fast processes. For slow processes, calculate the proportional band percentage from the equation below:

$$\text{Proportional Band Adjustment} = \frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}}$$

For example:

$$\frac{200 \times 2 \text{ Psig}}{30 \text{ Psig}} \cong 13\%$$

5. If the controller is used in conjunction with a control valve, return the control valve to service by slowly opening the upstream and downstream manual control valves in the pipeline. Close the manual bypass valve, if one is used.
6. Tune the various controller actions.

Tuning proportional action: Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting $\times 2$).

Tuning reset action: Disturb the system. If the system does not cycle, speed up the reset by changing the setting to a lower value (faster reset). Disturb the system again. Continue this procedure until the system cycles. When the system cycles, multiply the reset time setting by a factor of three (reset setting $\times 3$) and slow down the reset by changing the reset setting to the higher value. The reset is now tuned.

Tuning rate action: For a controller with rate (4194C controllers), adjust the rate toward the higher setting until cycling occurs. When the system cycles, divide the rate value by a factor of three (rate setting $\div 3$) and decrease the rate by changing the setting to the lower value. The rate is now tuned.

7. Check the stability of the recommended proportional band settings by introducing a disturbance and monitoring the process.
8. Once stable control is attained, the process pointer and set point indicator should be in line. If they are aligned, adjust the set point to the desired value. If they are not, readjust the set point to the desired control point and proceed with step 9.
9. If the process pointer is within 5 percent of the set point indicator, turn the link 3 adjustment (see figure 5-13 for location) until the process pointer aligns with the set point indicator. Turn the link 3 adjustment screw clockwise to increase the process indication or counterclockwise to decrease it. If the process pointer is misaligned with the set point indicator by more than 5 percent of the scale span, perform the calibration procedures for 4194B and C controllers.

Calibration of 4194B and C Controllers

⚠ WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not exceed the operating limits given in this manual.

General Calibration Instructions

Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing calibration.

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are found in figure 6-1.

Do not use the gauges supplied with the controller during calibration. Monitor process pressure, supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a regulated process differential pressure to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note

Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.

Refer to figures 4-1 and 4-2 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply process differential pressure equal to the process scale span lower limit.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.

5. Apply process differential pressure equal to the process scale span upper limit.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply process differential pressure equal to the mid-scale value on the process scale span. The process pointer should indicate the mid-scale mark, ±2 percent of span. If the error is greater than ±2 percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the locking screw and turning the zero adjustment screw. This distributes the error over the entire scale range and brings all points within ±1 percent of the process scale span.
10. Apply process differential pressure equal to the process scale lower limit.
11. The process pointer should indicate the process scale lower limit ±1 percent of the scale span.
12. Apply process differential pressure equal to the process scale upper limit.
13. The process pointer should indicate the process scale upper limit ±1 percent of the process scale span.
14. If the error is greater than ±1 percent, repeat steps 3 through 13.

Remote Set Point (suffix letter M) Zero and Span Calibration

Refer to figures 4-1 and 4-2 for adjustment locations. Refer to figures 6-1 and 6-5 for key number locations.

Note

Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Adjust the remote set point pressure to the mid-range value.
9. Make sure the set point indicator is within ±1 percent of the mid-scale mark, and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within ±2 percent of the mid-scale mark, proceed with step 10. If the set point indicator is not within ±2 percent, proceed to the remote set point zero and span adjustment procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid scale. Tighten the zero adjustment locking screw.
11. Apply the remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within ±1 percent.

12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

Flapper Alignment

Note

Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.

Flapper leveling screw numbers and adjustments are shown in figure 4-2. Key number locations are shown in figure 6-1.

Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.

Note

4194B and C controllers with anti-reset windup (suffix letter F) are supplied with two O-rings (key 52), a valve cover (key 51) and two machine screws (key 53). Use these parts in the next step.

1. For controllers with anti-reset windup (suffix letter F), record the direction of the arrow on the anti-reset windup relief valve (key 55). Remove the relief valve and install the two O-rings (key 52) and valve cover (key 51) supplied with the controller. Secure the valve cover with the two machine screws (key 53) provided.
2. If necessary, remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
3. Provide regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.
4. For a controller with manual set point, move the set point indicator to the mid-scale mark of the process scale span. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at mid-scale mark of the process scale.
5. Set the reset adjustment to 0.01 minutes per repeat.
6. If the controller has rate (4194C controllers), turn the rate adjustment to OFF.
7. Apply process differential pressure equal to the mid-scale value of the process scale span. If pressure is not available to pressure the input element to the mid-scale value, an alternate method is to disconnect link number 1 at the input element and tape the process pointer at mid-scale mark on the process scale. Note the hole where link number 1 is connected to the input element, then disconnect link 1. This method should only be used if pressure is not available to pressure the input element to the mid-scale value.

Note

Because of the high controller gain, the controller output will not remain stable in steps 8 through 12. The controller output gauge is adequate to check the output pressure during this procedure.

8. Set the proportional band between DIRECT and REVERSE.
9. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is relatively stable.

10. Set the proportional band to 30 percent DIRECT. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 3 (the screw nearest the nozzle) until the output is relatively stable.
11. Set the proportional band to 30 percent REVERSE. The controller output should be relatively stable within the output range. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is relatively stable.
12. Repeat steps 8 through 11 until the controller output remains relatively stable without further flapper leveling screw adjustment.

Note

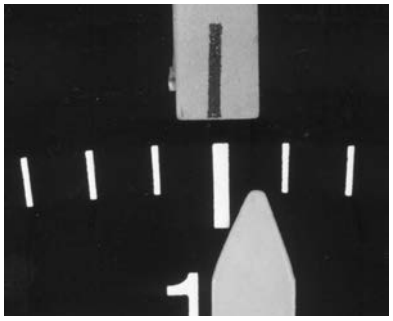
Steps 13 through 19 check the flapper alignment.

13. Set the proportional band to 30 percent DIRECT.
14. Apply process differential pressure to the input element or, if link 1 was disconnected, remove the tape from the process pointer and move the pointer until it aligns with the right-hand edge of the set point indicator as shown in figure 4-4.

    The controller output should be within 0.14 bar (2 psig) of the supply pressure.
15. Apply process differential pressure to the input element or, if disconnected, move the process pointer until it aligns with the left-hand edge of the set point indicator as shown in figure 4-4.

    The controller output pressure should go to 0 psig.

Figure 4-4. Alignment of the Process Pointer with the Set Point Indicator



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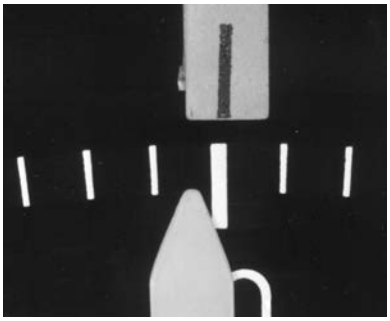

W4038-1

16. Set the proportional band to 30 percent REVERSE.
17. Apply process differential pressure to the input element or, if disconnected, move the process pointer until it aligns with the right-hand edge of the set point indicator as shown in figure 4-4. The controller output should be 0 psig.
18. Apply process differential pressure to the input element or, if disconnected, move the process pointer until it aligns with the left-hand edge of the set point indicator as shown in figure 4-4. The controller output should be within 0.14 bar (2 psig) of the supply pressure.
19. If the controller does not perform as indicated in steps 13 through 18, the flapper is not correctly aligned. This may occur because the output was not sufficiently stabilized in steps 8 through 12. Repeat steps 7 through 18.
20. Set the proportional band to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and tighten the two screws (key 6). Reconnect link number 1, if disconnected, to the same hole in the input element noted in step 7.

21. For controllers with anti-reset windup (suffix letter F), remove the two machine screws, valve cover and two O-rings installed in step 1 of this procedure. Install the anti-reset windup relief valve (key 55) with the arrow pointing in the direction recorded in step 1.

Anti-Reset Windup Differential Relief Valve Calibration

Calibration for the differential relief valve to relieve on rising controller output pressure

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.
2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4194C controllers only) to OFF.
3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark of the process scale.
4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 4-2 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on rising controller output pressure, install the valve so the arrow on the valve points down. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing down. Tighten the two mounting screws.
6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

7. Increase the process differential pressure to the controller until the controller output pressure balances at 0.4 bar (6 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output range or 0.8 bar (12 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output range.
8. Turn the reset adjustment to the CLOSED (4194B controllers) or OFF (4194C controllers) position.
9. Increase the controller output pressure in small steps [approximately 0.04 bar (0.5 psig)] by changing the process differential pressure or by changing the controller set point. After each change in differential pressure or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp upward to supply pressure with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 4-2. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 0.4 bar (5 psi) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Calibration for the differential relief valve to relieve on falling controller output pressure

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.

2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4194C controllers) to the OFF position.
3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark on the process scale.
4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 4-2 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on falling controller output pressure, install the valve so the arrow on the valve points up. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing up. Tighten the two mounting screws.
6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-4.

Note

Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.

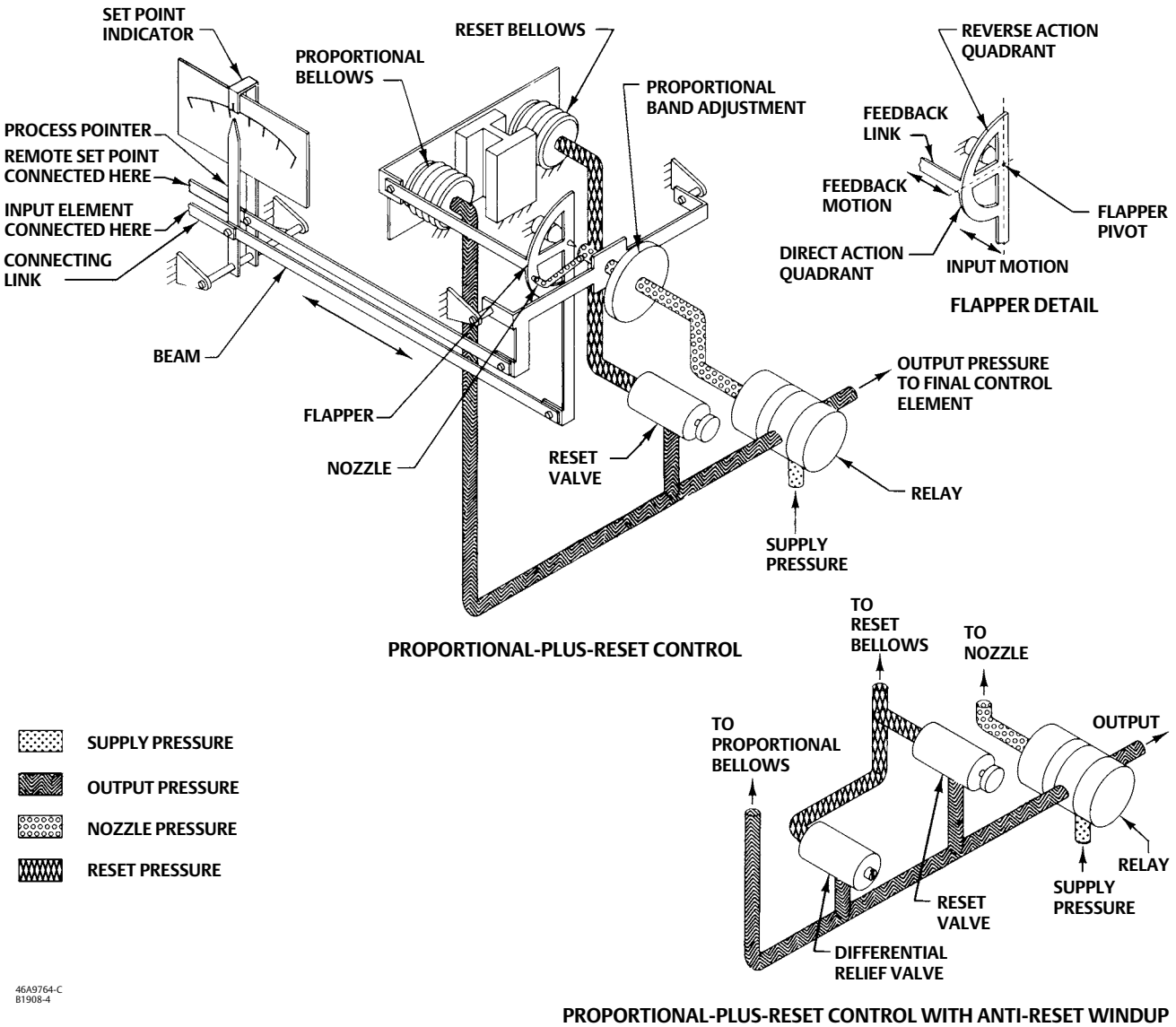
7. Increase the process differential pressure to the controller until the controller output pressure balances at 0.8 bar (12 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output range or 1.6 bar (24 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output range.
8. Turn the reset adjustment to the CLOSED (4194B controllers) or OFF (4194C controllers) position.
9. Decrease the controller output pressure in small steps (approximately 0.04 bar (0.5 psig)) by changing the process differential pressure or by changing the controller set point. After each change in differential pressure or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.04 bar (0.5 psi) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp downward to 0 psig with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 4-2. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 5 psi (0.4 bar) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

Principle of Operation for 4194B and C Controllers

Overall Operation

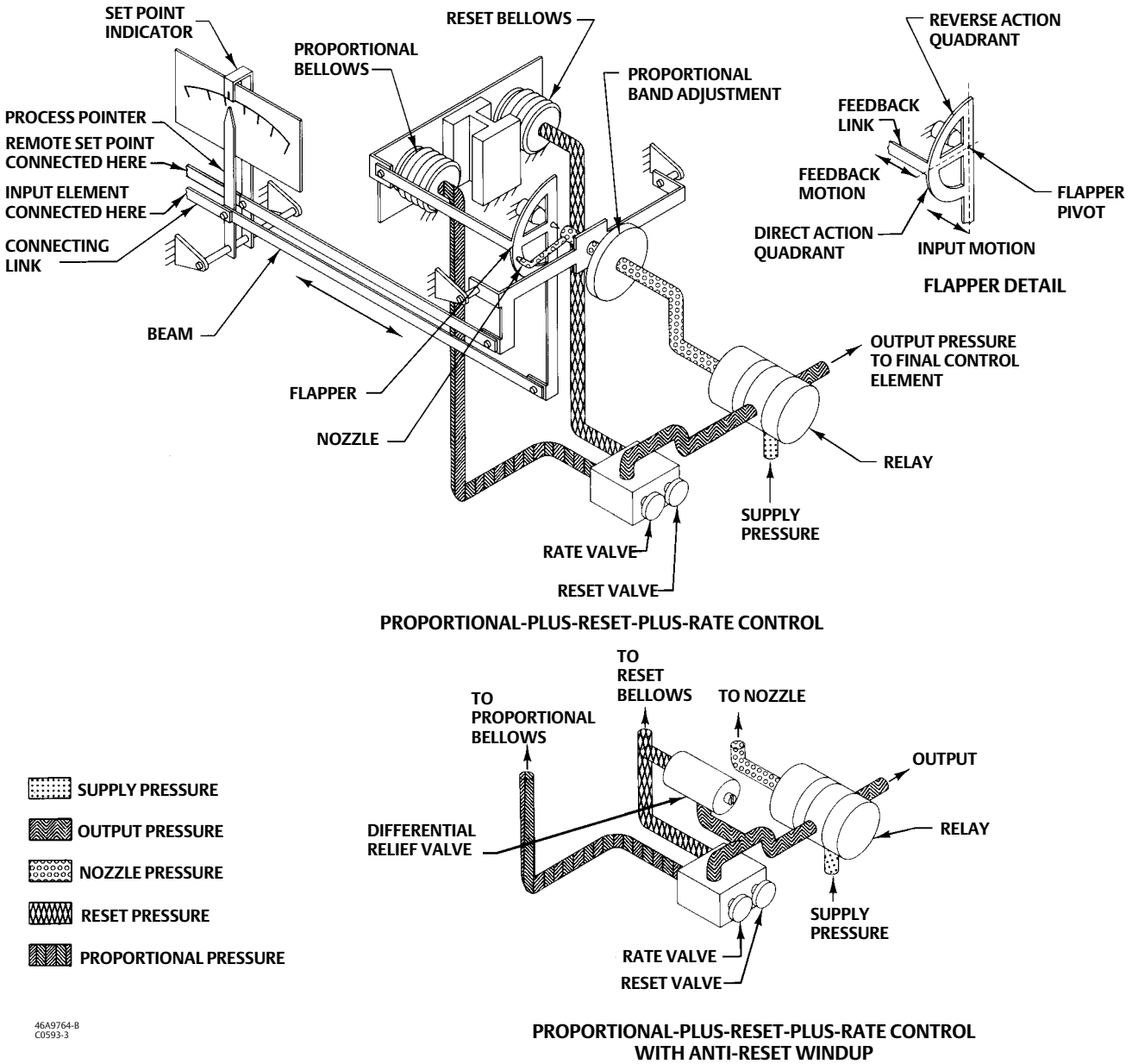
Refer to the schematic diagram in figure 4-5 for the 4194B controllers, or to the schematic diagram in figure 4-6 for 4194C controllers.

Figure 4-5. Fisher 4194B Controller Schematic



The input element is connected to the process pointer and to the flapper by connecting links. As the process differential pressure increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows and to the reset bellows. The action of the proportional bellows quickly counteracts the flapper movement that resulted from the process differential pressure change and backs the flapper away from the nozzle.

Figure 4-6. Fisher 4194C Controller Schematic



Pressure in the reset bellows opposes the action of the proportional bellows and slowly moves the flapper closer to the nozzle. The result of this interaction is that, when the process differential pressure changes, proportional action temporarily reduces the gain of the controller for improved stability. The process differential pressure then slowly returns to set point, as pressure in both bellows equalizes via reset action.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process pressure, except that when the set point is changed, the nozzle moves with respect to the flapper.

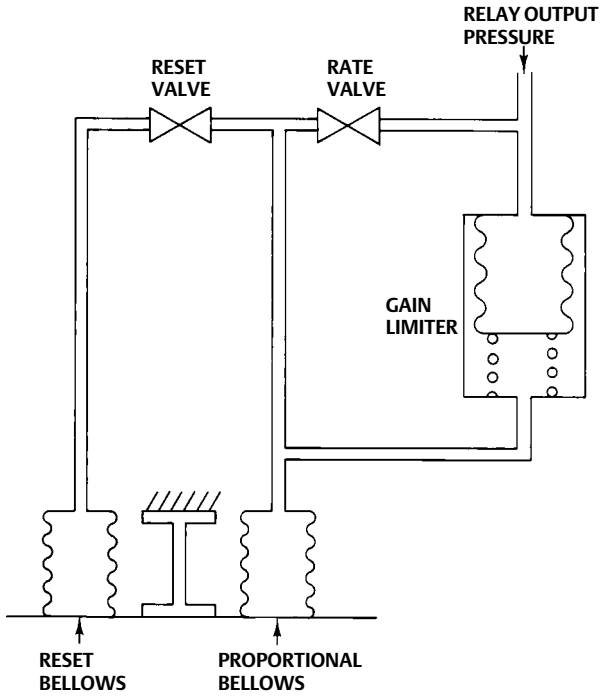
The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more

input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 4-5 or 4-6. With the controller in the reverse-acting mode, an increase in process differential pressure causes a decrease in output pressure.

A 4194C controller also has a rate valve as shown in figures 4-6 and 4-7. This valve is an adjustable restriction that momentarily increases the controller gain to accelerate the corrective action for slow responding systems. A proportional-plus-reset-plus-rate controller responds to a change in process differential pressure as follows:

- First, the rate action delays the proportional action just long enough to allow the controller to respond to the change quickly with high gain, but not long enough for the high gain to cause instability.
- Then, the low gain provided by the proportional action keeps the system stable. Finally, reset action slowly increases the gain and returns the process differential pressure toward the set point.

Figure 4-7. Reset-Rate Schematic



Anti-Reset Windup (suffix letter F) Operation

Anti-reset windup is available on all 4194B and C controllers and is designated by the letter F in the type number. The differential relief valve operates when the difference between proportional bellows pressure and reset bellows pressure reaches a predetermined value. Anti-reset windup reduces overshoot of the process differential pressure that can result from large or prolonged deviation from set point.

Remote Set Point (suffix letter M) Operation

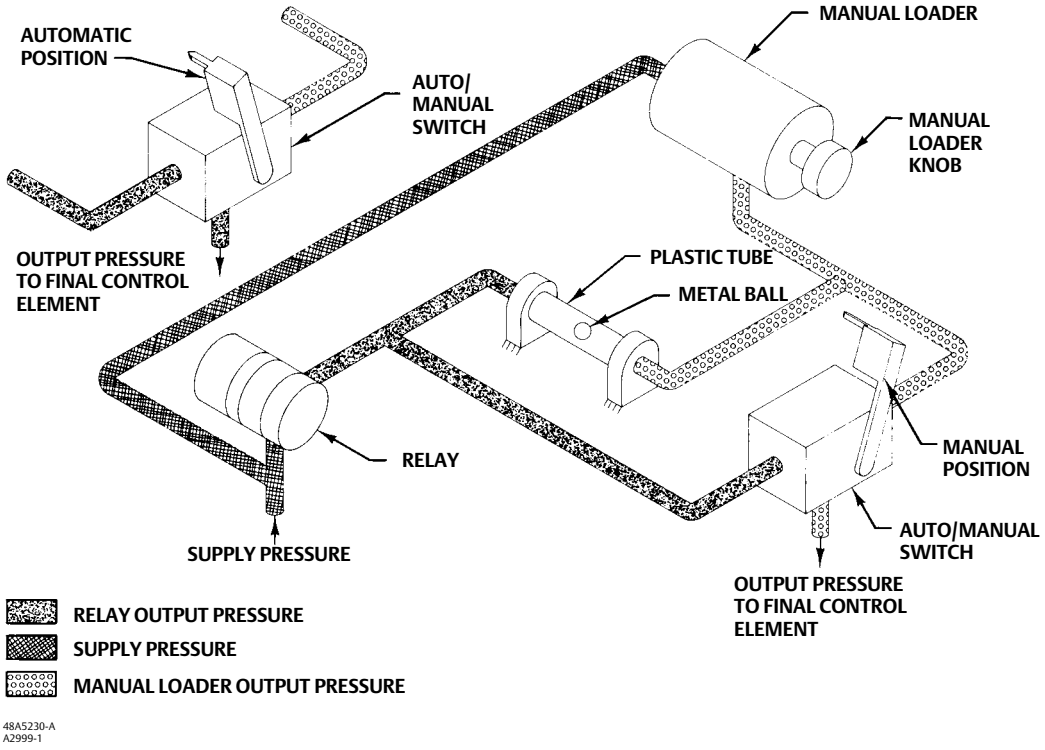
The capability to adjust the controller set point from a remote location is available with all 4194B and C controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

Auto/Manual Station (suffix letter E) Operation

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 4-8. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

Figure 4-8. Auto/Manual Station Schematic (Fisher 4194B and C Controllers)



When the auto/manual switch is in the MANUAL position, the manual loader output is channeled through the auto/manual switch and becomes the controller output. When the auto/manual switch is in the AUTO position, the relay output is channeled through the switch to become the controller output.

Before the auto/manual switch is operated, the relay output must equal the manual loader output to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

Section 5

Maintenance

Controller parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and parts replacement depends upon the severity of the service conditions. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job.

Inspection and Maintenance

⚠ WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and property damage caused by uncontrolled process pressure, observe the following before performing any maintenance procedures:

- **Always wear protective clothing, gloves, and eyewear.**
- **Provide some temporary means of control for the process before taking the controller out of service.**
- **Shut off the supply pressure to the controller.**
- **Disconnect any operating lines providing supply air pressure, a process input signal, or other pressure source to the controller.**
- **Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 11.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Note

Unless otherwise noted, key numbers refer to figures 6-1 through 6-6. Figures 3-1 and 3-3 show adjustment locations for 4194A controllers. Figures 4-1 and 4-2 show adjustment locations for 4194B and C controllers. For maintenance on the indicator assembly, refer to figures 6-2, 6-3, and 6-4.

Select the appropriate maintenance procedure, and perform the numbered steps. Shut off supply pressure and process pressure before beginning maintenance.

The maintenance procedures section describes part replacement common to 4194A, B, and C controllers. After completing the maintenance procedures, perform the appropriate calibration procedures. Unless otherwise noted, calibration procedures for the 4194A controller are in Section 3; calibration procedures for 4194B and C controllers are in Section 4. If difficulty is encountered performing the calibration procedures in Section 3 or 4, refer to the calibration procedures in this section.

Troubleshooting

As an aid to troubleshooting, table 5-1 lists some common operating faults, their probable cause, and suggests procedures for correcting the faults.

Table 5-1. Troubleshooting Chart

Fault	Possible Cause	Check	Correction
1. Process wanders or cycles about set point	1.1 Proportional band and reset settings	1.1 Refer to the Start-up section for controller settings.	1.1 If stable control cannot be attained, and all other elements of the loop are functionally correct, examine other possible causes related to the controller.
	1.2 Supply pressure varying	1.2 Monitor the supply pressure with an external gauge. Ensure that it is set correctly and does not fluctuate. Note the number of instruments being supplied by the regulator.	1.2 Correct as necessary. One regulator per instrument is recommended.
	1.3 Process pointer rubbing on cover or scale	1.3 Note if the pointer is bent.	1.3 Bend pointer to provide clearance.
	1.4 Input element failure	1.4 Inspect the element for loose screws and damaged flexures, links or pivots. Using a soap solution, check the sensing element for leaks.	1.4 Repair or replace parts as necessary.
	1.5 Linkage failure	1.5 Check for links bent or not connected properly, flexures bent or broken, pivots broken.	1.5 Replace or repair as necessary.
	1.6 Relay malfunction	1.6 By changing the process differential pressure and observing the output, verify that the output moves at about the same speed in both directions.	1.6 If the output moves fast in one direction and sluggishly in the other, replace the relay.
	1.7 Anti-Reset Windup differential relief valve set too low (suffix letter F only)	1.7 The minimum relief valve setting is dependent on the loop dynamics and the controller settings if, under normal load changes the relief valve opens, instability can occur. Check by observing the controller reaction to a set point or load change under closed loop conditions.	1.7 If the anti-reset windup differential relief valve appears to be set too low, perform the anti-reset windup calibration procedures in Section 4.
2. Controlling off set point as reflected by process and set point indicators. Note: Some offset is inherent with proportional only controllers (4194A controllers). The amount of offset is a function of the proportional band setting.	2.1 Supply pressure not set correctly	2.1 Check with an external source.	2.1 Reset the supply pressure if necessary. If the condition occurs again, rebuild or replace the regulator.
	2.2 Linkage not connected correctly.	2.2 Inspect for loose screws and damaged flexures, links or pivots.	2.2 Repair or replace parts as necessary.
	2.3 Leak in input element/tubing assembly.	2.3 Using soap solution, check the input element and tubing for leaks.	2.3 Repair or replace parts as necessary.
	2.4 Indicators out of calibration.	2.4 Refer to the process indicator and remote set point (if applicable) zero and span calibration procedures in Section 3 or 4.	2.4 Adjust as necessary.
	2.5 Flapper not aligned.	2.5 Refer to the Flapper alignment procedures in Section 3 or 4.	2.5 Align the flapper as necessary.
	2.6 Leak in feedback system.	2.6 Open the reset valve to .01 minutes/repeat. Adjust output pressure to 1.4 bar (20 psig). Using soap solution, check for leaks in the proportional and reset bellows and in the tubing that connects these bellows.	2.6 Repair as necessary.

-Continued-

Table 5-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
2. Controlling off set point as reflected by process and set point indicators.	2.7 Reset valve leaks.	2.7 Adjust output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the controller output varies and no leaks were found in the rest of the feedback system (Step 2.6), the reset valve is leaking.	2.7 Replace the reset valve.
	2.8 Leak in the remote set point system (suffix letter M only).	2.8 Adjust remote set point pressure to 1.0 bar (15 psig). Using soap solution, check for leaks in the remote set point element and tubing assembly.	2.8 Repair or replace parts as necessary.
	2.9 Input element over pressured.	2.9 Check for zero shift.	2.9 Replace input element and adjust travel stops.
3. Controlling off set point but not reflected by process and set point indicators.	3.1 Out of calibration	3.1 Refer to the process indicator, remote set point (if applicable), and flapper alignment procedures in Section 3 or 4.	3.1 Adjust as necessary
4. No reset action (4194B and 4194 controllers)	4.1 Reset valve is plugged	4.1 Turn the reset valve through its range several times to remove any restrictions.	4.1 If reset action returns, no further action is necessary. If not, replace the reset valve (4194B controllers) or the rate/reset valve (4194C controllers).
	4.2 Reset pressure leak	4.2 Adjust the output to 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or g2.0 bar (30 psi) for a 0.4 to 2.0 bar (6 to 30 psig) output. Close the reset valve. If the output varies and no leaks were found in the rest of the feedback system (see Step 2.6), the reset valve is leaking.	4.2 Replace the reset valve (4194B controllers) or the rate/reset valve (4194C controllers)
	4.3 Tubing leak	4.3 With reset valve positioned at 0.01 minutes/repeat, put 1.0 bar (15 psig) to the output port. Using soap solution, check for leaks in the reset bellows and attached tubing assembly.	4.3 Repair or replace parts as necessary.
5. Abnormal control point shift when proportional band is changed.	5.1 Flapper is dirty or pitted	5.1 Inspect the flapper.	5.1 Clean, or replace flapper as necessary.
	5.2 Flapper is out of alignment	5.2 Refer to flapper alignment procedures in Section 3 or 4.	5.2 Align flapper as necessary.
6. Controller will not attain full output range.	6.1 Output pressure gauge not functioning	6.1 Measure the output with an external pressure gauge.	6.1 Replace the gauge if it is defective.
	6.2 Supply pressure not correct	6.2 Check with an external source.	6.2 Repair or replace the supply pressure regulator, if necessary. Replace the supply pressure gauge if necessary.
	6.3 Proportional band setting two wide (4194A controllers only)	6.3 Adjust proportional band setting to 10. Manually cap the nozzle. Output should increase.	6.3 Use a narrower proportional band setting (decrease the proportional band setting).
	6.4 Input element or linkage failure	6.4 Inspect the element for alignment, loose screws and damaged flexures, links or pivots. Using soap solution, check the sensing element for leaks.	6.4 Repair or replace parts as necessary.

-Continued-

Table 5-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
6. Controller will not attain full output range.	6.5 Leak in nozzle pressure tubing	6.5 Using soap solution, check for leaks in the nozzle tubing assembly.	6.5 Replace faulty parts as necessary. Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged.
	6.6 Relay malfunction	6.6 Manually push the flapper away from the nozzle. The output pressure should be zero. Cap the nozzle. The output should increase rapidly to within 35 mbar (0.5 psig) of the supply pressure.	6.6 If the output does not change as described, remove the relay. Replace O-rings, if necessary. Replace relay, if necessary.
7. Controller remains at full output	7.1 Supply pressure too high	7.1 Check with an external pressure gauge.	7.1 Replace supply pressure regulator or gauge as necessary.
	7.2 Output gauge not functioning	7.2 Vary supply pressure to see if output gauge responds.	7.2 If output gauge does not respond, replace it.
	7.3 Input element or linkage failure	7.3 Vary the process differential pressure and observe the flapper for movement. Inspect the input element and linkage for damage.	7.3 Repair or replace parts as necessary.
	7.4 Mechanical alignment	7.4 Move the set point and verify that the nozzle is uncapped by the flapper. If not, inspect linkages and flexures for damage.	7.4 Repair or replace parts as necessary.
	7.5 Relay failure or restriction in nozzle passage	7.5 Manually move flapper 1.6 mm (1/16-inch) from the nozzle.	7.5 If the output pressure remains at the supply pressure, remove the controller case and cover assembly and test again with the relay nozzle tubing nut (key 18) loose. If the output is 0 psig, clean or replace the nozzle assembly. If the output remains at supply pressure, replace the relay.
	7.6 Flapper misaligned	7.6 Manually push the flapper away from the nozzle. Controller output should go to 0 psig.	7.6 Perform the flapper alignment procedures in Section 3 or 4.
8. Controller remains at zero output	8.1 Gauge not functioning	8.1 Verify that the supply pressure is at its correct value and that the controller output is zero.	8.1 Replace gauges as necessary
	8.2 Input element or linkage failure	8.2 Vary the process differential pressure and observe the flapper for movement. Inspect the input element and linkage for damage.	8.2 Repair or replace parts as necessary
	8.3 Mechanical alignment	8.3 Move the set point and verify that the nozzle is capped by the flapper. If not, inspect linkages and flexures for damage.	8.3 Repair or replace parts as necessary
	8.4 Relay malfunction	8.4 Check for air at the nozzle. Cap the nozzle and note that the controller output increases to within 0.5 psig of supply pressure.	8.4 Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged. If the problem persists, replace the relay.
	8.5 Nozzle pressure leak	8.5 Using a soap solution, check for nozzle tubing leaks with the nozzle capped by the flapper. Press the nozzle cap (key 23) gently to ensure nozzle O-ring (key 24) is sealing. Ensure the relay nozzle tubing nut (key 18) and the manifold screws (keys 34 and 131) are tight.	8.5 Tighten the relay nozzle tubing nut (key 18), tighten manifold screws (keys 34 and 131), or replace nozzle assembly O-ring or set point beam assembly as appropriate.

Replacing Common Controller Parts

⚠ WARNING

To avoid personal injury or property damage caused by the uncontrolled release of pressure, be sure any trapped process pressure is properly vented from the controller. Vent any supply pressure from the controller before disassembly.

Replacing the Process Pressure Scale

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

CAUTION

To prevent the pointer or set point indicator from rubbing on the cover or scale, and producing an inaccurate indication, take care not to bend the process pointer or the set point indicator while performing the following procedure.

Refer to figure 5-1.

Figure 5-1. Changing the Scale

W3440

DEFLECT LOWER PORTION OF THE SLOT

W3492

AND LIFT THE SCALE UP AND OFF

1. Adjust the set point indicator (either manually or with the remote set point pressure) to the mid-scale mark on the process scale.
2. Remove the four self-tapping screws (key 37).
3. Slide the process scale (key 61) downward so that the top of the slot touches the set point indicator. Deflect the lower portion of the slot outward and carefully slide the scale up and off, clearing the set point indicator as shown in figure 5-1.
4. To install the replacement scale, deflect the lower part of the slot slightly so that the scale slides downward over the set point indicator and under the process pointer.

5. Secure the scale with the four self-tapping screws (key 37).
6. If the controller has remote set point (suffix letter M), perform the appropriate remote set point zero and span calibration procedure in Section 3 or 4.
7. Perform the appropriate process indicator zero and span calibration and the flapper alignment procedures in Section 3 or 4.

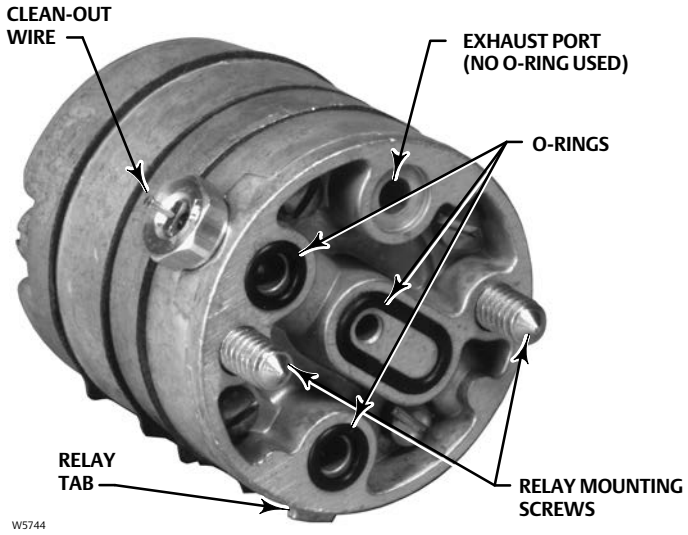
Replacing the Relay

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Loosen the two captive screws that hold the relay (key 50) in place.
2. Tip the relay slightly toward the side of the case to clear the output pressure gauge (key 46) and lift out the relay.
3. Make sure the replacement relay has three O-rings (keys 13 and 15) installed as shown in figure 5-2. The fourth port is for exhaust and does not require an O-ring.
4. Install the replacement relay, making sure the tab on the relay, shown in figure 5-2, aligns with the tab on the frame.

Figure 5-2. Relay Construction



5. Tighten the two screws that hold the relay in place.
6. Perform the appropriate Flapper Alignment procedure in Section 3 or 4.

Replacing the Case and Cover

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

CAUTION

The case and cover are an integral unit; attempting to separate them will damage the hinge. If the cover needs to be replaced, replace the case also.

1. Remove the external piping and fittings from the controller.
2. Remove the controller from its mounting to a maintenance area.
3. Remove the nine screws (key 38) from the case and cover assembly (key 1) and lift out the controller assembly. If the controller has remote set point (suffix letter M), use a screwdriver or appropriate tool to deflect the case slightly at the remote set point connection to remove the controller assembly. Inspect the O-rings around the external piping connections and replace as necessary.
4. Position the controller assembly in the replacement case and cover.
5. Start the nine mounting screws, but do not tighten.
6. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
7. Remove the blow-out plug (key 72) from the original case, and install it in the replacement case.
8. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.
9. Mount the controller as described in the Installation section.
10. Connect the external piping to the controller.

Replacing the Gauges

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

CAUTION

Before performing this procedure, be sure the replacement gauges are the correct range so that they are not damaged by overpressure.

1. Unscrew the output pressure gauge (key 46) or the supply pressure gauge (key 47) from the frame (key 3).
2. Before installing the replacement gauge, coat the threads on the gauge with a sealant such as key 311.
3. Screw the replacement gauge into the frame.
4. Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure.

Replacing the Pressure Control Block

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. After bleeding away pressure, remove the process pressure or remote set point piping from the controller.
2. At the pressure control block (key 57), unscrew the nut that secures the capsular element tubing so that the tubing can be removed from the pressure control block.
3. Remove the two cap screws (key 58) that hold the pressure control block to the frame, and lift out the pressure control block.
4. Install the O-ring (key 7) on the replacement pressure control block.
5. Position the replacement pressure control block on the frame and fasten with the two cap screws (key 58).
6. Insert the tubing from the capsular element into the pressure control block and tighten the nut loosened in step 2.
7. Apply pressure equal to the maximum value on the process scale, and check for leaks.
8. Reconnect the piping, removed in step 1, to the controller.

Replacing the Supply Gauge, Proportional, Reset, and Reset Valve Tubing Assemblies

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Unscrew the nuts at each end of the tubing assembly. Remove the tubing assembly.
3. Install the replacement tubing assembly.
4. Set the reset adjustment to 0.01 (4194B and C controllers) and set the rate adjustment to OFF (4194C controllers).
5. Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure. Then, remove the pressure.
6. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
7. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.
8. Mount the controller as described in the Installation section.
9. Connect external piping to the controller.

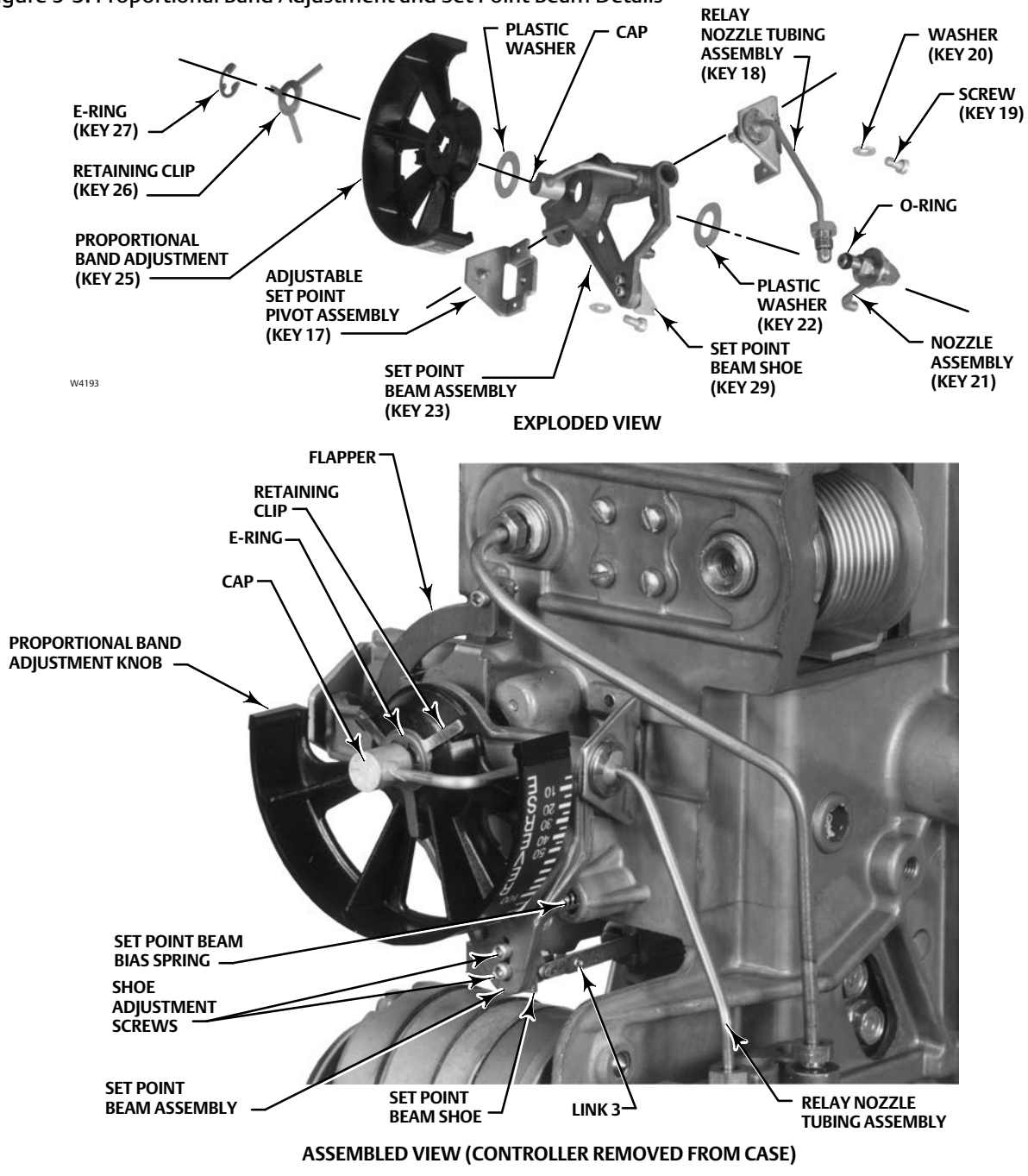
Replacing the Proportional Band Adjustment Knob, Nozzle Assembly, and Set Point Beam Assembly

Figure 5-3 shows the parts locations for the proportional band adjustment and set point beam. Unless otherwise noted, refer to this figure while performing the following procedures.

Disassembly

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Remove the two machine screws (key 6), and lift off the proportional band indicator cover (key 36). See figure 6-1 for parts location.
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23).
4. Remove the set point beam bias spring (key 28).
5. Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame, and remove the pivot assembly.
6. Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135).

Figure 5-3. Proportional Band Adjustment and Set Point Beam Details



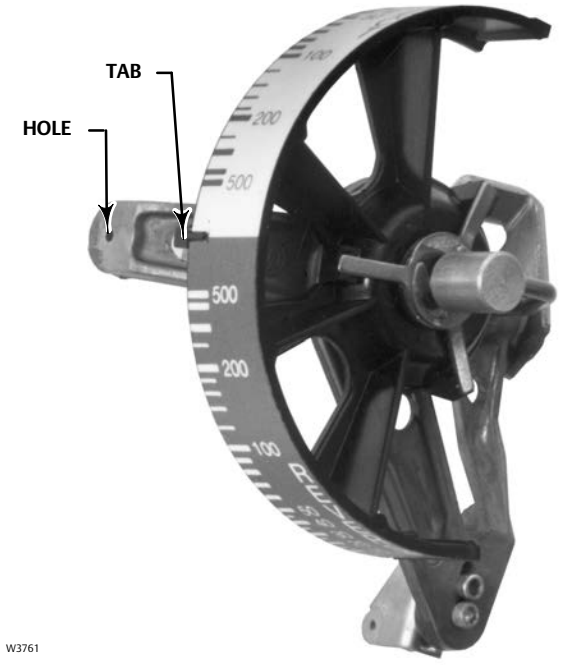
7. While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
8. Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
9. Remove the relay nozzle tubing assembly (key 18) from the set point beam assembly (key 23).

10. Remove the E-ring (key 27) from the nozzle assembly (key 21).
11. Remove the nozzle assembly (key 21) and plastic washer (key 22) from the bottom of the set point beam assembly (key 23).
12. Remove the retaining clip (key 26).
13. Remove the proportional band adjustment knob (key 25) and plastic washer from the set point beam assembly (key 23).
14. Inspect the nozzle assembly (key 21), and replace it if necessary. Inspect the nozzle orifice, and clean it, if necessary. Also, inspect the plastic washers, and replace them if necessary.
15. Inspect the nozzle assembly O-ring (key 24) and replace it, if necessary.

Assembly

1. Apply a suitable lubricant, such as key 318, to the set point beam assembly; then position a plastic washer (key 22) and the proportional band adjustment knob (key 25) on the set point beam assembly (key 23) as shown in figure 5-3.
2. Position the retaining clip (key 26) on the three posts of the proportional band adjustment knob.
3. Place the second plastic washer on the nozzle assembly. Apply a suitable lubricant, such as key 317, to the nozzle assembly O-ring.
4. Insert the nozzle assembly (key 21) through the set point beam assembly (key 23), the plastic washer (key 22), the proportional band adjustment knob (key 25) and the retaining clip (key 26) into the cap. Align the nozzle with the tab on the proportional band adjustment knob shown in figure 5-4; make sure the proportional band adjustment knob engages the flats on the nozzle assembly.

Figure 5-4. Proportional Band Adjustment Knob Setting



5. While holding the nozzle assembly (key 21) against the set point beam assembly (key 23), depress the retaining clip (key 26), and install the E-ring (key 27) into the E-ring groove on the nozzle assembly (key 21). Ensure that all three tabs of the E-ring are engaged.
6. Inspect the O-ring on the relay nozzle tubing assembly (key 18) and replace it, if necessary. Apply a suitable lubricant to the O-ring.

7. Install the relay nozzle tubing assembly (key 18) into the set point beam assembly.
8. Set the proportional band adjustment between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 5-4.
9. Position the proportional band adjustment knob, relay nozzle tubing assembly and the set point beam assembly on the frame. Screw the relay nozzle tubing nut loosely into the frame manifold.
10. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.
11. Center the nozzle on the flapper as shown in figure 5-5 while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.
12. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).
13. Insert the screw, with washer (keys 19 and 20), through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.
14. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws.
15. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 5-6 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.

Figure 5-5. Nozzle-Flapper Positioning

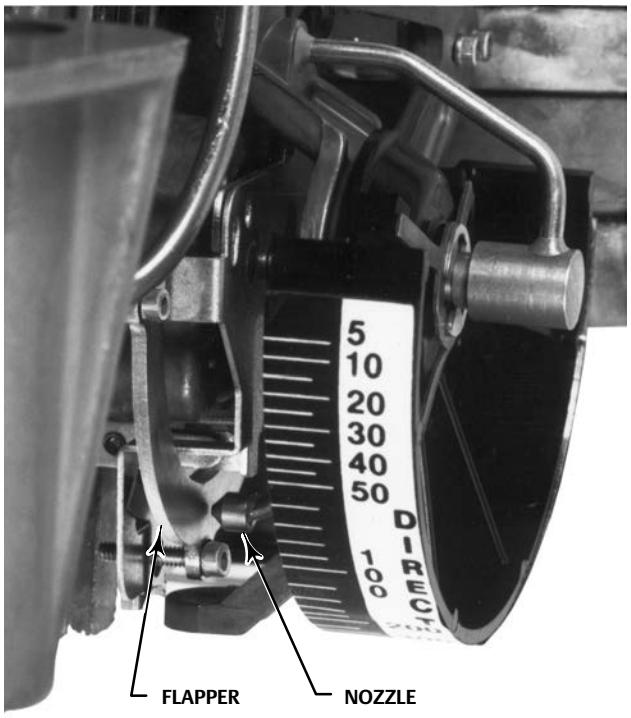
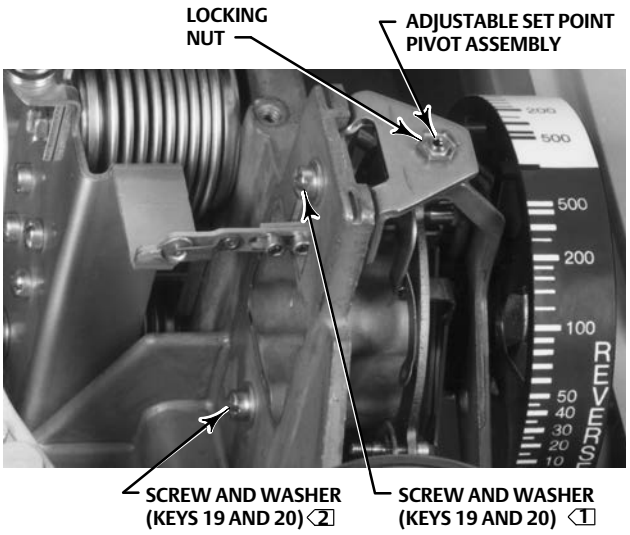


Figure 5-6. Adjustable Set Point Pivot Assembly Locking Nut Location



NOTES:
1 SCREW INSERTED INTO THE ADJUSTABLE SET POINT PIVOT ASSEMBLY.
2 SCREW INSERTED INTO THE RELAY NOZZLE TUBING ASSEMBLY.

16. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped and check for leaks. Remove supply pressure.
17. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat on the set point beam assembly.
18. Attach link 3 to the set point beam shoe as shown in figure 5-3.
19. For controllers with reset or rate adjustment (4194B or 4194C controllers), turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position. Set the rate adjustment to the OFF position.

    The controller output must be 0 bar (0 psig). To be sure the controller output is 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position.
20. Apply the correct supply pressure (refer to table 1-4) to the controller and provide an accurate means of measuring the controller output pressure.
21. Perform the appropriate process indicator zero and span calibration procedure and, if necessary, the remote set point zero and span calibration procedure in Section 3 or 4. When calibration is complete, continue with step 22 below.

Note

The following procedure (steps 22 through 28) matches the process pointer motion to the set point indicator motion so the controller will control at set point at all positions on the process scale.

22. Set the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.
23. Adjust the set point to the lower limit on the process scale.
24. Disconnect link 1 from the input element, noting the hole from which it is removed and tape the process pointer to the lower limit on the process scale. The output pressure may be anywhere between 0.2 to 1.0 bar (3 and 15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or between 0.4 to 2.0 bar (6 and 30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.
25. Adjust the set point to the upper limit on the process scale.
26. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 24. Note the process pressure indication.
27. The process pressure indication should be within ±2 percent of the upper limit on the process scale.

    If the process pressure indication in step 26 is greater than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 5-3, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

    If the process pressure indication in step 26 is less than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 5-3, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.
28. Repeat steps 23 through 27 until the error is less than 2 percent of the process scale range at the upper limit of the process scale.
29. Remove the tape from the process pointer and reconnect link 1 to the input element. Be sure to reconnect link 1 in the same hole noted in step 24.
30. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.

31. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.
32. Mount the controller as described in the Installation section.
33. Connect external piping to the controller.

Replacing the Flapper Assembly and Flapper Flexure Pivot Assembly

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23). Refer to figure 5-3 for the link location.
4. Remove the set point beam bias spring (key 28), refer to figure 5-3 for the spring location.
5. Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame.
6. Remove the adjustable set point pivot assembly (key 17).
7. Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135). Refer to figure 5-3.
8. While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
9. Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
10. Disconnect link 2 from the flapper assembly (key 11). Refer to figure 5-7 for the link location.
11. Disconnect link 4 from the bellows bracket (key 31). Refer to figure 5-7 for the link location.
12. Remove the two cap screws (key 12) from the flexure pivot assembly (key 9). See figure 5-8 for screw location.
13. Remove the flapper assembly and link 4 as shown in figure 5-9.
14. Remove the four machine screws (key 10), shown in figure 5-9, that hold the flexure pivot assembly to the frame.
15. Remove the flexure pivot assembly (key 9).
16. Install the replacement flexure pivot assembly with the four screws (key 10). Do not tighten the screws.
17. With the controller in the upright position, move the flexure pivot assembly down as far as possible, and tighten the four screws (key 10).
18. Place the flapper assembly (key 11) on the flexure pivot assembly (key 9) with link 4 through the hole in the frame.
19. Position the flapper assembly (key 11) on the flexure pivot assembly (key 9) and start the cap screws (key 12) that hold the flapper assembly to the flexure pivot assembly. Do not tighten the screws.
20. Align flapper leveling screw number 2 with the centerline of the oblong hole in the frame as shown in figure 5-8. Tighten the cap screws (key 12).

Note

The following procedure (steps 21 through 23) adjusts link 2 to ensure that it will always be in tension to eliminate possible instability due to lost motion.

21. Disconnect link 1 from the input element, noting the hole location, and manually position the process pointer to the process scale upper limit. Tape the pointer in this position.

Figure 5-7. Bellows Assembly and Proportional Band Adjustment (Process Scale and Proportional Band Indicator Cover Removed)

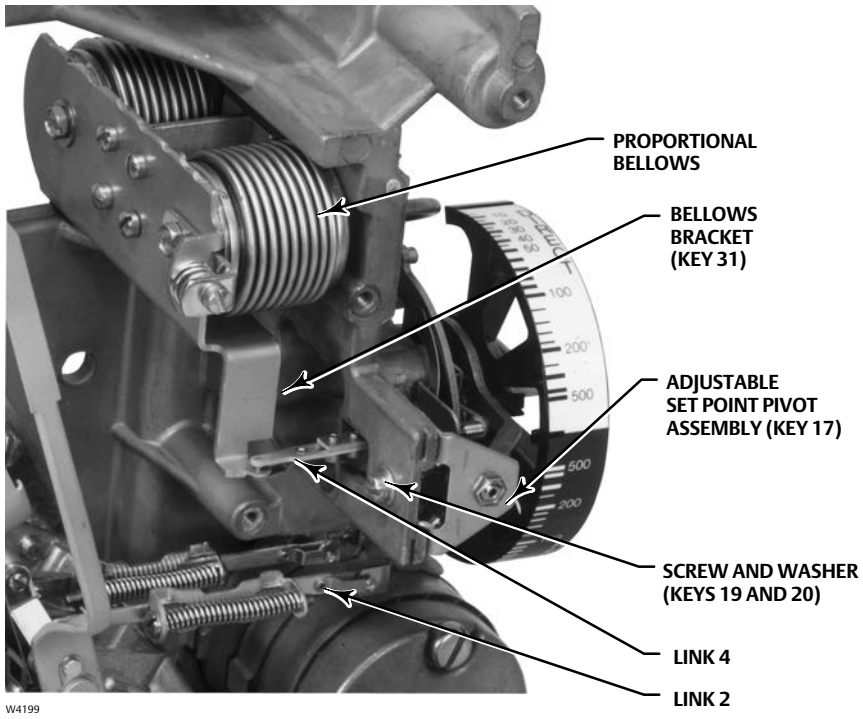


Figure 5-8. Leveling Screw Alignment

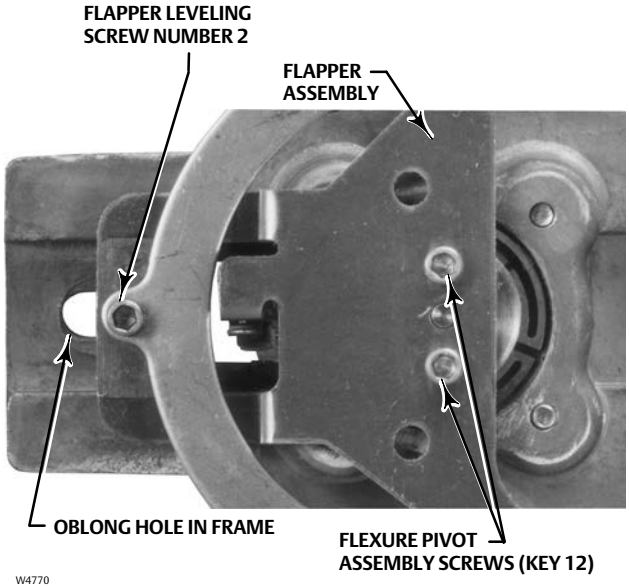
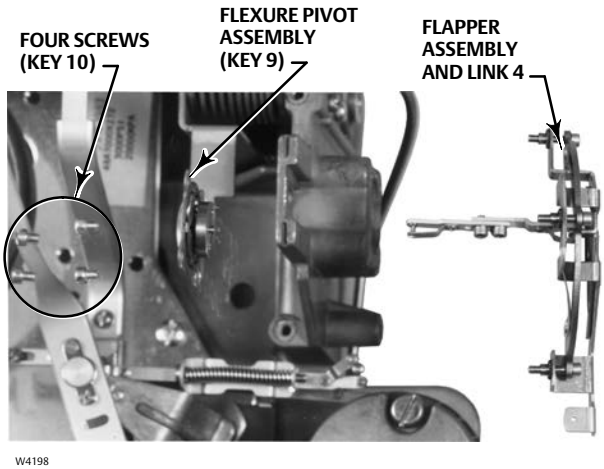


Figure 5-9. Exploded View of Flexure Pivot Assembly



22. Adjust the length of link 2 by turning the adjustment screw, shown in figure 5-10, clockwise to increase the length or counterclockwise to decrease the length, so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly, as shown in figure 5-11.
23. Connect link 2 to the flapper assembly.
24. Set the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 5-4.
25. Position the proportional band adjustment knob, nozzle assembly, set point beam assembly, and nozzle tubing assembly on the frame, and screw the relay nozzle tubing assembly nut loosely onto the frame manifold (key 135).
26. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.
27. Center the nozzle on the flapper as shown in figure 5-5 while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.
28. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).
29. Insert the screw, with washer (keys 19 and 20), through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.
30. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws.
31. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 5-6 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.
32. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped (to obtain maximum output pressure) and check for leaks. Remove supply pressure.
33. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat on the set point beam assembly, as shown in figure 5-3.
34. Attach link 3 to the set point beam shoe as shown in figure 5-3.

Note

The following procedure (steps 35 through 41) adjusts link 4 so it will always be in compression to eliminate possible instability due to lost motion.

35. For controllers with reset and rate adjustments (4194B or 4194C controllers), remove the supply pressure; then, turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position.

    The controller output must be 0 bar (0 psig). To be sure the controller output is at 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position.
36. Apply the correct supply pressure (refer to table 1-4) to the controller and provide an accurate means of measuring the controller output pressure.
37. Adjust the proportional band to 5 percent REVERSE and adjust the set point to the process scale upper limit.
38. With link 1 disconnected, tape the process pointer at the process scale lower limit. The output pressure should be within 0.14 bar (2 psig) of supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.

Figure 5-10. Link 2 and 4 Adjustment Locations

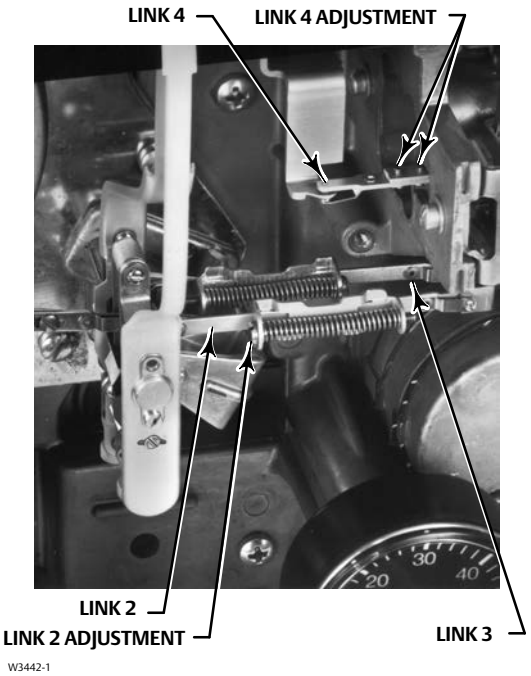
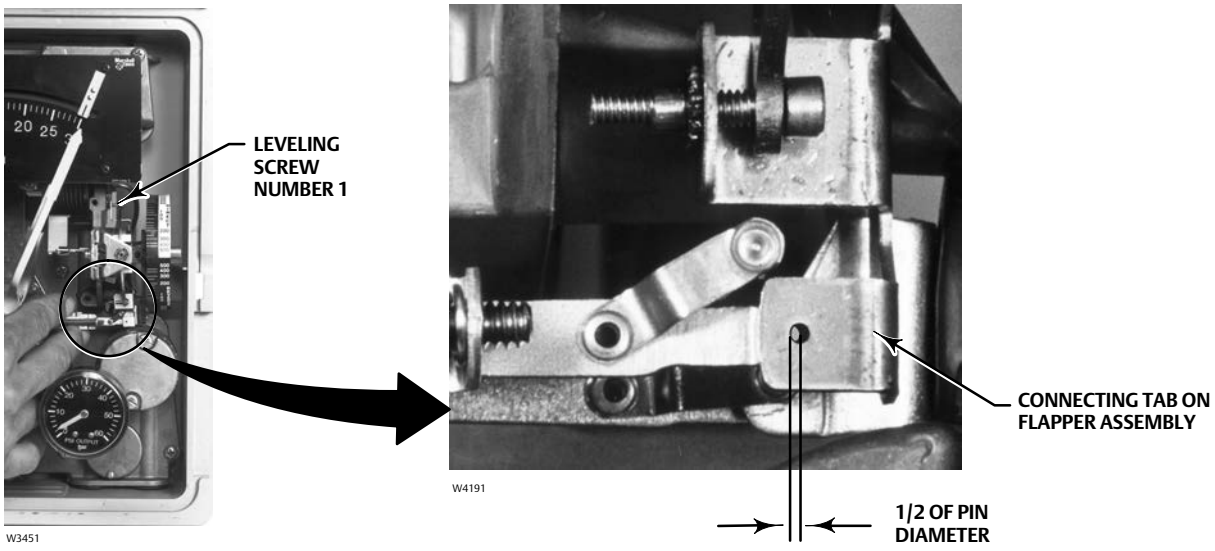


Figure 5-11. Link 2 Adjustment



39. Loosen the two adjustment screws on link 4, shown in figure 5-10, and connect the link to the bellows bracket (key 31), allowing the link to find its free length.
40. Tighten the two adjusting screws on link 4.
41. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, repeat steps 39 and 40.
42. Adjust the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.

43. Adjust the set point to the process scale lower limit.
44. Tape the process pointer at the process scale lower limit. The output pressure may be anywhere between 0.2 to 1.0 bar (3 and 15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output signal range or between 0.4 to 2.0 bar (6 and 30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.
45. Adjust the set point to the process scale upper limit.
46. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 44. Note the process pressure indication.
47. The process pressure indication should be within ±2 percent of the process scale upper limit.

    If the process pressure indication in step 46 is greater than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 5-3, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

    If the process pressure indication in step 46 is less than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 5-3, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.
48. Repeat steps 43 through 47 until the error is less than 2 percent of the process scale span at the process scale upper limit.
49. Remove the tape from the process pointer and reconnect link 1 to the input element. Be sure to reconnect the link to the same hole noted in step 21.
50. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
51. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.
52. Mount the controller as described in the Installation section.
53. Connect external piping to the controller.

Replacing the Proportional or Reset Bellows

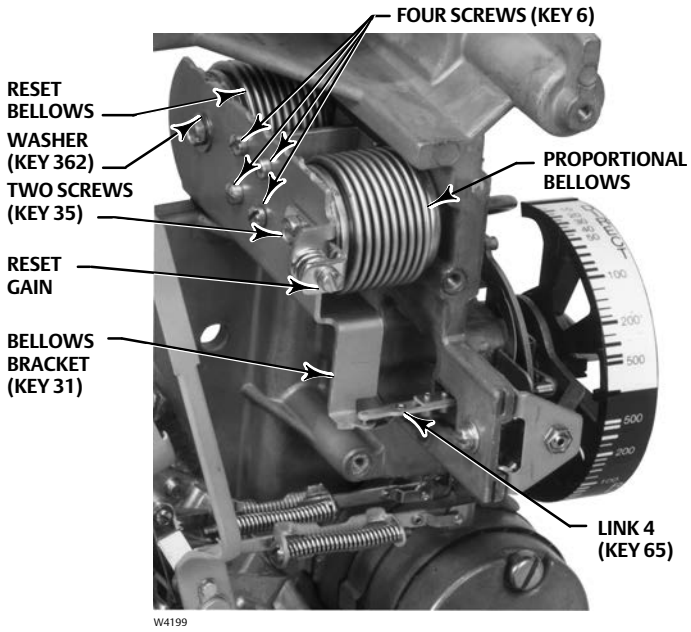
Refer to figure 5-12, unless otherwise noted.

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
3. Disconnect link 4 (key 65) from the bellows bracket (key 31).
4. Remove the two machine screws (key 35) and washer (key 362) from the bellows assemblies.
5. Remove the four machine screws (key 6) from the bellows beam (key 49) and remove the bellows bracket (key 31).
6. Remove the proportional tubing assembly (key 40) from the proportional bellows, or remove the reset tubing assembly (key 43) from the reset bellows, depending on which bellows are to be replaced.
7. Remove the four machine screws (key 71) from the bellows beam and remove the bellows beam from the frame.

CAUTION

When removing and replacing the proportional or reset bellows, keep in mind that the bellows has left-hand threads. Overtightening could damage the threads.

Figure 5-12. Bellows Assembly, Bellows Bracket, and Bellows Beam Location



Note
Both bellows need not be removed if only one requires replacement.

8. Unscrew the bellows assembly (key 48). If the bellows assembly cannot be removed by hand, thread a machine screw (key 35) into the bellows until tight; then loosen the bellows assembly by applying clockwise torque to the machine screw.
9. Before installing the replacement bellows, coat the threads with a suitable lubricant, such as key 310. Screw in the replacement bellows until it is finger tight against the frame (key 3).
10. Reinstall the bellows beam (key 49) and tighten the machine screws (key 71).
11. Position the bellows bracket (key 31) over the bellows. Insert a machine screw (key 35) through the bellows bracket (key 31) and into the proportional bellows. Do not tighten.
12. Place the washer (key 362) on the second machine screw (key 35) and start the screw through the bellows bracket (key 31) into the reset bellows. Do not tighten.
13. Compress the bellows and start the four machine screws (key 6) through the bellows bracket (key 31) into the bellows beam (key 49), but do not tighten.
14. Be sure that the bellows bracket is aligned such that it does not rub on the frame at any point and tighten the screws (key 6 and 35).
15. Install the proportional or reset tubing assembly on the bellows base.
16. For a 4194B or C controller, set the reset adjustment for 0.01 minutes per repeat. For a 4194C controller, set the rate adjustment to OFF.
17. Apply the correct supply pressure with the nozzle capped and check for leaks. Remove the supply pressure.
18. Reconnect link 4 (key 65) to the bellows bracket. Be sure that the link does not contact the frame. If it does, loosen the four screws (key 6) that attach the bellows bracket to the bellows beam and reposition the bellows bracket to provide clearance. Be sure the bellows bracket does not rub on the frame; then, tighten the screws.

19. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, perform steps 35 through 41 of the Flapper Assembly and Flapper Flexure Pivot Assembly replacement procedures.
20. If the controller is proportional-only (4194A controllers), go to step 34. If the controller has reset (4194B or C controllers), continue with step 21.

Note

The following procedure (steps 21 through 32) adjusts the reset gain of the controller to minimize steady-state offset.

21. Apply the correct supply pressure to the controller and provide an accurate means of measuring controller output pressure. Also, provide a means of applying regulated differential process pressure.
22. Adjust the proportional band to 100 percent DIRECT.
23. Adjust the set point to the mid-scale mark on the process scale.
24. Adjust the reset adjustment to 0.01 minutes per repeat. For a 4194C controller, set the rate adjustment to OFF.
25. Increase the process differential pressure until the output pressure stabilizes at 0.2 bar (3 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 0.4 bar (6 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Record the process differential pressure reading.

Note

When the reset valve is at 0.01, the controller is very sensitive to any process pressure change. Only small process pressure changes may be necessary.

26. Very slowly increase the process differential pressure until the output pressure stabilizes at 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output. Record the process differential pressure reading.
27. If the difference between the recorded process differential pressures in step 25 and step 26 is larger than ±1 percent of the process scale span, proceed with step 28. If the difference is less than ±1 percent, go to step 33.
28. Loosen the proportional bellows screw (key 35).
29. If the reading recorded in step 26 is greater than in step 25, adjust the reset gain screw (key 34) one-half turn in (clockwise). If the reading recorded in step 26 is less than in step 25, adjust the reset gain screw (key 34) one-half turn out (counterclockwise).
30. Tighten the proportional bellows screw (key 35).
31. Repeat steps 25 through 30 until the difference is less than ±1 percent of the process scale span.
32. If ±1 percent of the process scale span cannot be achieved by adjusting the gain screw (key 34), loosen the machine screw (key 35) attaching the reset bellows and slide it to the left if the reading in step 26 is greater than in step 25, or to the right if the reading in step 26 is less than in step 25. Tighten the screw and repeat steps 25 through 31.
33. Remove the supply pressure, the output measurement device, and the regulated differential process pressure source.
34. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
35. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

36. Mount the controller as described in the Installation section.
37. Connect external piping to the controller.

Replacing the Reset Restriction Valve (4194B Controllers)

Refer to the 4194B controller portion of figure 6-1 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Remove the reset valve tubing assembly (key 42) from the reset restriction valve (key 54).
3. Remove the reset tubing assembly (key 43) from the reset restriction valve.
4. For controllers with anti-reset windup (suffix letter F), remove the relief valve tubing assembly (key 44) from the reset restriction valve.
5. Remove the screw (key 162) that fastens the reset restriction valve to the frame.
6. Install the replacement reset restriction valve and secure it with the screw removed in step 5.
7. Install the reset valve tubing assembly (key 42), the reset tubing assembly (key 43), and for controllers with anti-reset windup, the relief valve tubing assembly (key 44). Tighten all connections.
8. Set the reset adjustment to 0.01 minutes per repeat.
9. Apply the proper supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.
10. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
11. Perform the controller calibration procedures and, if necessary, the remote set point calibration procedure in Section 4.
12. Mount the controller as described in the Installation section.
13. Connect external piping to the controller.

Replacing the Rate/Reset Valve Assembly (4194C Controllers)

Note

Read this entire procedure before removing any parts. Refer to the 4194C controller portion of figure 6-1 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Remove the two machine screws (key 71) on the side of the rate/reset valve assembly (key 262).
3. Gently pull the rate tubing assembly away from the rate/reset assembly and remove the gasket (key 5) from the side of the rate/reset assembly.
4. Unscrew the nut holding the reset tubing assembly (key 43) into the rate/reset valve assembly.
5. Unscrew the nut holding the proportional tubing assembly (key 40) into the rate/reset assembly.
6. For controllers with anti-reset windup (suffix letter F), unscrew the nut holding the relief tubing assembly into the rate/reset assembly.
7. While holding the rate/reset valve assembly, remove the machine screw (key 162) from the frame.

8. Remove the rate/reset valve assembly from the frame.
9. Inspect, and if necessary, replace the gasket (key 5).
10. To install the replacement rate/reset valve assembly, position the assembly on the frame (key 3) and secure it with the mounting screw (key 162).
11. Position the gasket (key 5) on the rate/reset valve assembly. Hold the gasket in place while installing the rate tubing assembly (key 137) on the valve assembly using the two machine screws (key 71).
12. Insert the reset tubing assembly (key 43) into the rate/reset valve assembly and tighten the nut.
13. Insert the proportional tubing assembly (key 40) into the rate/reset valve assembly and tighten the nut.
14. For controllers with anti-reset windup (suffix letter F), insert the relief tubing assembly (key 44) into the rate/reset valve assembly and tighten the nut.
15. Set the reset to 0.01 minutes per repeat and the rate to OFF.
16. Apply the proper supply pressure to the controller, cap the nozzle and check for leaks.
17. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
18. Perform the controller calibration procedures and, if necessary, the remote set point calibration procedure in Section 4.
19. Mount the controller as described in the Installation section.
20. Connect external piping to the controller.

Replacing the Anti-Reset Windup (suffix letter F) Differential Relief Valve

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Refer to the 4194B or 4194C controller suffix letter F portion of figure 6-1 for key number locations.

1. Loosen the two mounting screws in the differential relief valve (key 55), and remove the relief valve.
2. Inspect the O-rings on the replacement relief valve. Apply a suitable lubricant to the O-rings.
3. Install the replacement relief valve into the controller frame, keeping in mind that:
   - When the arrow points up, the valve relieves with decreasing output pressure.
   - When the arrow points down, the valve relieves with increasing output pressure.
4. Tighten the two screws that hold the relief valve to the frame.
5. The relief valve differential pressure is factory-set at 0.3 bar (5 psig). Maximum differential pressure is 0.5 bar (7 psig); minimum differential pressure is 0.14 bar (2 psig). If a different differential pressure setting is desired, refer to the anti-reset windup valve calibration procedure in Section 4.

Replacing the Anti-Reset Windup (suffix letter F) Relief Valve Tubing Assembly

Refer to the 4194B or 4194C controller suffix letter F portion of figure 6-1 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.

2. Loosen the nuts at both ends of the relief valve tubing (key 44), and remove the tubing.
3. Install the replacement relief valve tubing, and tighten the tubing nuts at both ends.
4. Apply the proper supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.
5. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
6. Perform the controller calibration procedures and, if necessary, the remote set point calibration procedure in Section 4.
7. Mount the controller as described in the Installation section.
8. Connect external piping to the controller.

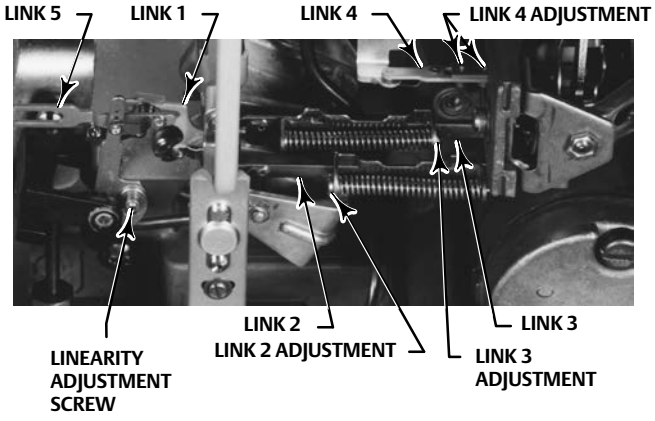
Replacing the Links

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

This section describes the separate replacement of five links in the controller. Figure 5-13 shows the location of each link. To clarify the location of each link, the links are numbered as follows:

Figure 5-13. Link Locations



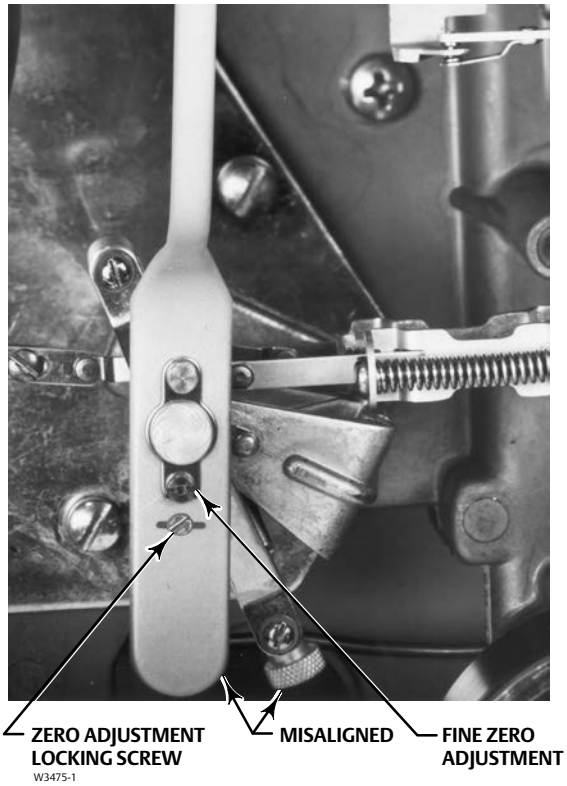
- Link 1 connects the short pivot clevis assembly and the process pointer
- Link 2 connects the process pointer and the flapper assembly (key 11)
- Link 3 connects the set point indicator and the set point beam assembly (key 23)
- Link 4 (key 65) connects the flapper assembly and the bellows bracket (key 31)
- Link 5 (key 88 in figure 6-3) connects the short pivot clevis assembly (key 89) and the long pivot clevis assembly (key 78).

Replacing Link 1

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Note the hole position of link 1 and disconnect the link from the short pivot clevis assembly and from the process pointer. Remove the link.

3. Attach the replacement link in the same holes noted in step 2 to the process pointer and the short pivot clevis assembly. If you do not know in which hole in the process pointer the link was connected, place it in the middle hole. If during the process indicator zero and span calibration, the pointer will not travel the full scale, even after full span adjustment, move the link to the bottom hole (the hole nearest the pointer pivot). If the process pointer has too much travel, move the link to the top hole (the hole furthest from the pointer pivot).
4. Move the set point indicator, manually or with remote set point pressure, to the mid-scale mark on the process scale and set the proportional band between DIRECT and REVERSE.
5. The process pointer should be aligned with the pointer subassembly as shown in figure 5-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the process pointer and pointer subassembly. Tighten the zero adjustment locking screw.

Figure 5-14. Process Pointer Alignment



6. Apply process differential pressure equal to the mid-scale value of the process scale span. The process pointer should indicate mid-scale ±3 percent of the process scale span. If not, loosen the screw in link 1 or link 5, and move the pointer to the mid-scale mark on the process scale. Tighten the screw.
7. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing Link 2

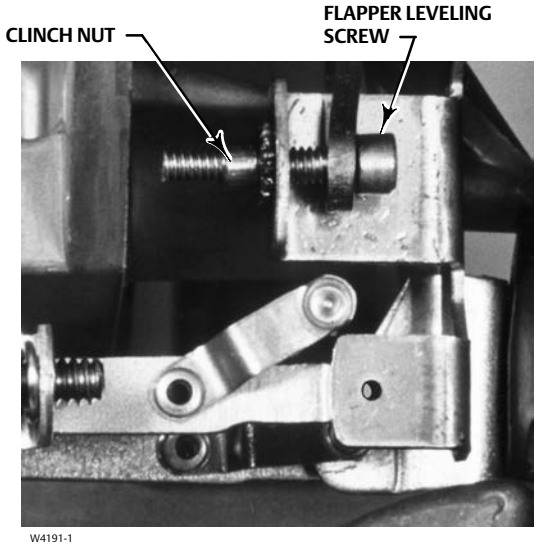
1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 2 from the process pointer and from the flapper assembly (key 11). Remove the link.
3. Install the replacement link with the screw head nearest the process pointer as shown in figure 5-13. Connect the link to the process pointer only.
4. The process pointer should be aligned with the pointer subassembly as shown in figure 5-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the pointer with the process pointer subassembly. Tighten the zero adjustment locking screw.

5. Move the set point indicator, manually or with remote set point pressure, to the process scale lower limit and set the proportional band to 5 percent REVERSE. The nozzle should not be touching the flapper. If it is, adjust flapper leveling screw 1 (the screw nearest the nozzle) until clearance is obtained.
6. Note the hole position and disconnect link 1 from the short pivot clevis assembly. Manually position the process pointer to the process scale upper limit and tape the process pointer in this position.
7. Adjust the length of link 2 (by turning the adjusting screw clockwise to increase the length or counterclockwise to decrease the length) so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly as shown in figure 5-11. This adjustment provides the proper tension on the link to eliminate lost motion.
8. Connect link 2 to the flapper assembly.
9. Remove the tape from the process pointer and reconnect link 1 to the hole in the short pivot clevis assembly noted in step 6.
10. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing Link 3

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 3 from the set point indicator and the set point beam assembly (key 23).
3. Adjust the replacement link to the same length as the link removed.
4. Install the replacement link with the screw head toward the set point beam assembly as shown in figure 5-13.
5. Check that the set point beam bias spring (key 28) is correctly located in the frame bore and the spring seat on the set point beam assembly as shown in figure 5-3.
6. Move the set point indicator to the mid-scale mark on the process scale.
7. Apply process differential pressure to position the process pointer at the mid-scale mark on the process scale.
8. Adjust the proportional band to 5 percent DIRECT. Turn flapper leveling screw 3 (the screw nearest the nozzle) until the nozzle just touches the flapper.
9. Adjust the proportional band to 5 percent REVERSE. Turn flapper leveling screw 1 (the screw nearest the nozzle) until the nozzle just touches the flapper.
10. Flapper leveling screws 1 and 3 should protrude the same distance from the clinch nuts. A clinch nut is shown in figure 5-15.

Figure 5-15. Flapper Leveling Screw and Clinch Nut

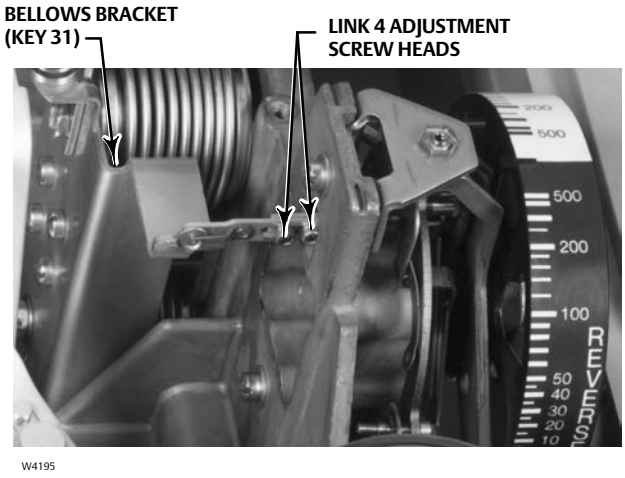


11. If leveling screw 1 protrudes further than leveling screw 3, turn the link 3 adjusting screw counterclockwise. If leveling screw 3 protrudes further than leveling screw 1, turn the link 3 adjusting screw clockwise.
12. Repeat steps 8 through 11 until leveling screws 1 and 3 protrude an equal distance from the clinch nuts.
13. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing Link 4

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 4 from the bellows bracket (key 31) and the flapper assembly (key 11).
3. Connect the replacement link to the flapper assembly so that the two adjusting screws on the link are nearest to the bellows bracket (key 31) and so that the screw heads are facing the bottom of the controller as shown in figure 5-16.

Figure 5-16. Position of Link 4 Adjustment Screws



4. For controllers with reset (4194B controllers) or reset and rate adjustments (4194C controllers), turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position. Turn the rate adjustment (4194C controllers) to the OFF position.

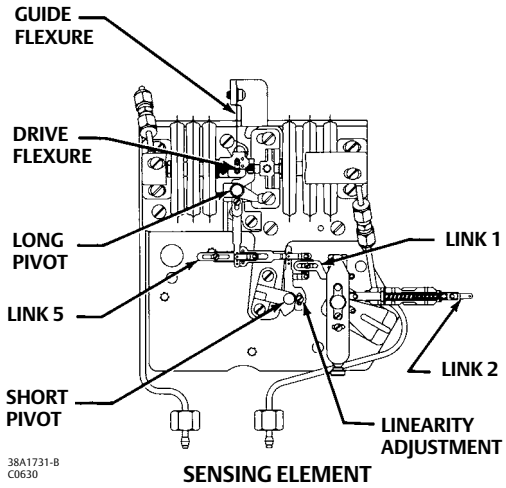
   The controller output must be 0 bar (0 psig). To be sure the controller output is at 0 bar (0 psig), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4194B) or OFF (4194C) position.
5. Adjust the proportional band to 5 percent REVERSE and move the set point indicator to the process scale upper limit.
6. Disconnect link 1 from the pivot arm. Tape the process pointer to the process scale lower limit (the last mark on the left side of the scale).
7. Apply the correct supply pressure to the controller. The output of the controller should be within 0.14 bar (2 psig) of supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.
8. Loosen the two adjusting screws on link 4. Connect the free end of the link to the bellows bracket and allow the link to find its free length.
9. Tighten the two adjusting screws on the link.
10. Raise link 4 out of the hole in the bellows bracket (key 31) and ensure that it drops back into the hole under its own weight. If not, repeat steps 8 and 9.

11. For a controller with reset, adjust the reset adjustment to 0.01. The rate adjustment (4194C) should remain in the OFF position.
12. The controller output should be within 0.14 bar (2 psig) of the supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 0.14 bar (2 psig) of supply pressure.
13. Remove the tape from the process pointer and connect link 1 to the pivot arm.
14. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing Link 5

1. Note the location of the connection holes and disconnect both ends of link 5 (key 88) from the lever arms of the two pivot assemblies. Refer to figure 5-17 for parts locations.

Figure 5-17. Process Input Capsular Element Assembly Part and Adjustment Locations



2. Loosen the adjustment screw on the replacement link, and adjust the length to match the original link. Tighten the adjustment screw.
3. Attach the replacement link to the two lever arms in the same holes noted in step 1.
4. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
5. Move the set point indicator (manually or with remote set point pressure) to the mid-scale mark on the process scale. Set the proportional band between DIRECT and REVERSE.
6. The process pointer should be aligned with the pointer subassembly as shown in figure 5-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the process pointer and pointer subassembly. Tighten the zero adjustment locking screw.
7. Apply the process differential pressure equal to the mid-scale value of the process scale span. The process pointer should indicate mid-scale ±3 percent of the scale span. If not, loosen the screw in link 1 or link 5, move the process pointer to the mid-scale mark ±3 percent of the scale span. Tighten the screw.
8. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing the Capsular Element Assembly

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Refer to figures 6-2 and 6-3 for key number locations.

1. Remove process pressure from the controller.
2. Note the hole location and disconnect link 1 (key 90) from the process pointer.
3. Disconnect the process pressure connection unions (key 93) from the pedestal assembly (key 81). Use two 5/16-inch hex wrenches.
4. Remove the four mounting screws (key 127) that attach the capsular element assembly to the indicator assembly (key 101).

CAUTION

In the following step, do not lift out the capsular element assembly by holding the capsular element or linkages. These parts may be damaged.

5. Lift out the capsular element assembly by holding the tie bar (key 97), mounting plate (key 77), travel stop (key 83), or pedestal assembly (key 81).
6. Position the replacement capsular element assembly over the mounting screw holes. Install and tighten the mounting screws (key 127).
7. Reconnect link 1 (key 90) to the process pointer in the same hole noted in step 2.
8. Reconnect the process pressure connection unions (key 93).
9. Apply process differential pressure to the controller, and check for leaks.
10. Perform the capsular element maintenance calibration procedures in this section. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing the Long Pivot Assembly

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

CAUTION

Avoid bending or kinking the drive flexure during the following procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

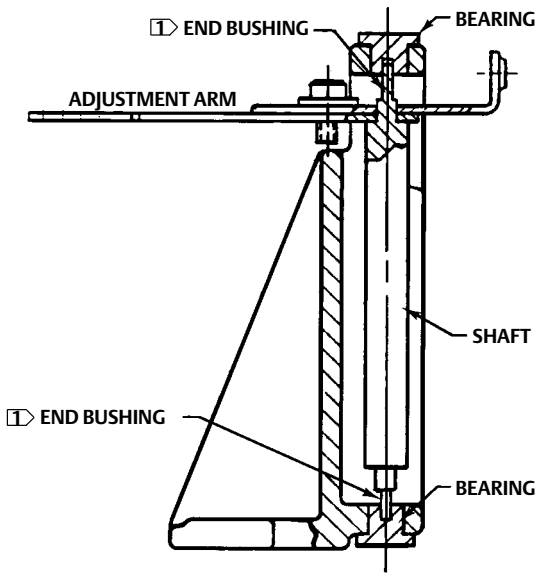
Refer to figure 6-3 for capsular element key number locations.

1. Remove process pressure from the controller.
2. Remove the tie bar (key 97) from the capsular element assembly by removing the mounting screws (key 103).
3. Note the hole position of link 5 (key 88) and disconnect the link from the pivot adjustment arm on the long pivot clevis assembly (key 78).
4. Using an Allen wrench, remove the cap screw and washer (keys 12 and 13) that attach the drive flexure (key 79) to the pivot adjustment arm of the long pivot clevis assembly. Take care not to bend or kink the drive flexure.

5. Remove the two screws (key 102) attaching the long pivot clevis assembly to the mounting plate (key 77).
6. Loosen the screw on the pivot adjustment arm of the replacement pivot clevis assembly, and adjust the arm to the same length as the arm on the pivot assembly being replaced.
7. Attach the replacement pivot clevis assembly to the mounting plate with the two mounting screws (key 102).
8. Loosely connect the drive flexure to the pivot adjustment arm of the new pivot clevis assembly.

   See figure 5-18. The adjustment arm of the long pivot clevis assembly is connected to a shaft that turns on bushings at each end of the shaft. In the next step, position the shaft so that both bushings "float" inside the bearings and do not rest against the end of either bearing.
9. Apply 75 percent of the capsular element range to the capsule. The drive flexure should be straight and horizontal. Before tightening the drive flexure cap screws (key 12), hold the pivot shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure cap screws to hold the pivot shaft in position. Adjust the length of the pivot adjustment arm as needed until the drive flexure is horizontal. Take care not to kink or twist the flexure when tightening the screws.
10. Connect the left-hand end of link 5 (key 88) to the pivot adjustment arm in the hole position noted in step 3.
11. Replace the tie bar (key 97).
12. Perform the capsular element maintenance calibration procedures in this section. Perform the controller calibration procedures and, if necessary, perform the appropriate remote set point calibration procedure in Section 3 or 4.

Figure 5-18. Cutaway of Long Pivot Clevis Assembly



NOTE:
1 BEFORE TIGHTENING THE DRIVE FLEXURE MOUNTING SCREWS, POSITION THE SHAFT SO THE END BUSHINGS "FLOAT" IN THE BEARINGS.
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Replacing the Short Pivot Assembly

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Refer to figure 6-3 for capsular element key number locations.

1. Remove the process pressure from the controller.
2. Note the hole positions of links 1 and 5 (keys 88 and 90) and disconnect the links from the short pivot clevis assembly (key 89). Also, note the screw position of the linearity adjustment for later reference.
3. Remove the two machine screws (key 102) attaching the short pivot clevis assembly (key 89) to the mounting plate (key 77), and remove the pivot clevis assembly.
4. Set the linearity adjustment screw on the replacement pivot clevis assembly to approximately the same location as noted in step 2. The linearity adjustment screw location is shown figure 5-17.
5. Position the replacement short pivot clevis assembly on the mounting plate, and attach it with the two mounting screws.
6. Attach links 1 and 5 (keys 88 and 90) in the same hole position as noted in step 2.
7. Perform the capsular element maintenance calibration procedures in this section. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Replacing the Process Drive Flexure

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

CAUTION

Avoid bending or kinking the drive flexure during the following procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

Refer to figure 6-3 for the capsular element key number locations.

1. Set the process pressure to 75 percent of the capsular element span.
2. Remove the tie bar (key 97) from the capsular element assembly by removing the mounting screws (key 103).
3. Using an Allen wrench, remove the cap screws and washers (keys 12 and 13) to disconnect the drive flexure (key 79) from the drive bracket assembly (key 84) and from the pivot adjustment arm of the long pivot clevis assembly (key 78). Remove the drive flexure.
4. Loosely connect the replacement drive flexure, making sure it is straight and horizontal.

Note

See figure 5-18. The adjustment arm of the long pivot clevis assembly is connected to a shaft that turns on bushings at each end of the shaft. In the next step, position the shaft so that both bushings “float” inside the bearings and do not rest against the end of either bearing.

5. Before tightening the drive flexure cap screws (key 12), hold the pivot shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure cap screws to hold the pivot shaft in position. Take care not to kink or twist the flexure when tightening the screws.

6. Perform the capsular element maintenance calibration procedures in this section. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedures in Section 3 or 4.

Replacing the Process Tubing

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Remove process pressure from the controller.
2. Using two open-end 5/16-inch wrenches, disconnect the process tubing (keys 91 or 92) at the pedestal assembly (key 81) and at the bottom of the controller case. Remove the tubing.
3. Install the replacement tubing, and tighten all connections. Check for leaks.
4. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Capsular Element Maintenance Calibration

Precalibration Procedures

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Remove the two machine screws (key 6) and lift off the proportional band cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Remove the two screws (key 103) and remove the tie bar (key 97) from the capsular element assembly.

Aligning the Drive Bracket Assembly

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Refer to figures 5-17 and 6-3.

1. With an Allen wrench, loosen the set screw in the hex nut (key 86) of the drive bracket assembly (key 84).
2. Loosen the screw (key 98) that holds the guide flexure to the tab on the mounting plate (key 77). The guide flexure location is shown in figure 5-17.
3. Apply process differential pressure equal to 75 percent of the capsular element range.
4. Slide the drive bracket assembly (key 84) along the diaphragm capsule extension (key 82) until the guide flexure is aligned with the center of the long pivot clevis assembly (key 78).

5. Tighten the machine screw (key 98) and the set screw in the hex nut to fasten the drive bracket assembly in that position.

Setting the Travel Stops

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Loosen the set screw in the travel stop nut (key 86).

Note

Make sure the loose travel stop nut does not bind on the diaphragm capsule extension when pressurizing the capsules. Damage to the capsules may result.

2. For Full span stop—Apply process differential pressure equal to 5 percent greater than the capsular element range.

Loosen the screws (key 139) that secure the travel stop (key 83) to the mounting plate (key 77). Slide the travel stop until it is just touching the end of the capsule stack. Tighten the travel stop mounting screws to lock it into position. Decrease the input pressure to 100 percent of the capsular element range and make sure the capsule stack is not contacting the travel stop (key 83).

3. Zero stop—Adjust process differential pressure input to 0 percent of the capsular element range.

Slide the travel stop nut (key 86), along the diaphragm capsule extension (key 82) until it is approximately 0.4 mm (1/64-inch) away from the travel stop. Tighten the set screw to lock the travel stop nut in position.

Aligning the Linkage

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Refer to figure 5-17 and 6-3.

1. Adjust the process differential pressure input to 75 percent of the capsular element range. The drive flexure (key 79) should be straight and horizontal. If it is not, proceed as follows:
   a. Loosen the screw on the pivot adjustment arm on the long pivot clevis assembly (key 78) and the two screws mounting the drive flexure.
   b. Adjust the length of the pivot adjustment arm so that the drive flexure is parallel to the centerline of the capsules. Tighten the screw to set the length of the pivot adjustment arm in that position.

Note

See figure 5-18. The adjustment arm of the long pivot clevis assembly is connected to a shaft that turns on bushings at each end of the shaft. In the next step, position the shaft so that both bushings “float” inside the bearings and do not rest against the end of either bearing.

c. Before retightening the drive flexure screws, hold the long pivot clevis assembly shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing.

d. Tighten the drive flexure screws to hold the pivot clevis assembly shaft in position.

2. Set the linearity adjustment screw on the short pivot clevis assembly so the two arms of the short pivot clevis assembly are parallel. The linearity adjustment screw should be near the center of its slot.
3. Make certain that the process pointer and pointer subassembly are aligned as shown in figure 5-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment screw to align the process pointer and pointer subassembly. Tighten the zero adjustment locking screw.
4. Adjust the process differential pressure input to 50 percent of capsular element range.
5. Loosen the screw on link 5 (key 88) and adjust the link length so that the pivot arms of the short pivot clevis assembly (key 89) and the long pivot clevis assembly (key 78) are parallel. Tighten the screw.
6. Complete the maintenance calibration by performing the zero and span adjustments in the following procedure.

Zero and Span Adjustment

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Note

For routine zero and span calibration, refer to the appropriate procedures in Section 3 or 4. Use the following maintenance zero and span adjustment procedure only if difficulty is encountered with the routine procedure or if nonlinearity occurs.

Provide a means of applying process differential pressure to the sensing element and a regulated supply pressure adjusted to the normal operating pressure (see table 1-4). Plug the controller output or connect it to a gauge. Monitoring the controller output is not necessary. However, the flapper should not contact the nozzle at any time while performing this procedure. If it does, adjust flapper screw 2 (the screw nearest the nozzle) to provide clearance.

Refer to figure 5-19 for the adjustment locations. Refer to figure 6-1 for the key number locations.

Note

Any adjustment of the process pointer span adjustment screw requires readjustment of the process pointer zero adjustment screw.

1. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the reset valve (4194B and C controllers only) to 0.01 minutes per repeat.
4. Adjust the rate (4194C controllers only) to OFF.
5. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark on the process scale.
6. Apply a process differential pressure equal to the mid-scale value of the process scale span.

7. The process pointer should be aligned with the pointer subassembly as shown in figure 5-14. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw to align the process pointer with the pointer subassembly. Tighten the zero adjustment locking screw.
8. The process pointer should indicate mid-scale ±3 percent of the process scale span. If not, loosen the screw on either link 1 or link 5 and adjust the length so that the process pointer points to the mid-scale mark on the process scale. Tighten the screw.
9. Apply process differential pressure equal to the process scale lower limit.
10. The process pointer should indicate the process scale lower limit. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw until the process pointer indicates the lower limit. Tighten the zero adjustment locking screw.
11. Apply process differential pressure equal to the process scale upper limit.
12. The pointer should indicate the process scale upper limit. If not, proceed as follows:

    a. If the pointer indicates less than the process scale upper limit, rotate the pointer span adjustment clockwise to increase the span. Adjust the span adjustment screw to correct for half of the error.

    b. If the pointer indicates greater than the process scale upper limit, rotate the pointer span adjustment counterclockwise to decrease the span. Adjust the span adjustment screw to correct for half of the error.

13. Repeat steps 9 through 12 until the zero and span indications are within ±1 percent of the scale limits with no further adjustment. If the span adjustment screw is adjusted to its limit and the span is still too short or too long, proceed with step 14. If proper span is achieved, proceed to step 16.
14. Within the process pointer subassembly, there are three holes for the connection of link 1. Use procedure (a.) or (b.) below to make the coarse span adjustment with link 1.

    a. If the span is short (process pointer indication is less than the process scale upper limit), disconnect link 1 from the process pointer subassembly, move the link to the lowest hole (the hole nearest the pointer pivot), and return to step 9. If the link is already in the lowest hole, proceed to step 15.

    b. If the span is long (process pointer indication is greater than the process scale upper limit), disconnect link 1 from the process pointer subassembly, move the link to the highest hole (hole furthermost from the pointer pivot), and return to step 9. If the link is already in the highest hole, proceed to step 15.

15. At either end of link 5, there are four holes in which the link may be connected. A coarse span adjustment can be made by moving both ends of link 5 up or down.

    a. If the span is short (process pointer indication is less than the process scale upper limit), disconnect both ends of link 5, move the link down one set of holes, and return to step 6.

    b. If the span is long (process pointer indication is greater than the process scale upper limit), disconnect both ends of link 5, move the link up one set of holes, and return to step 6.

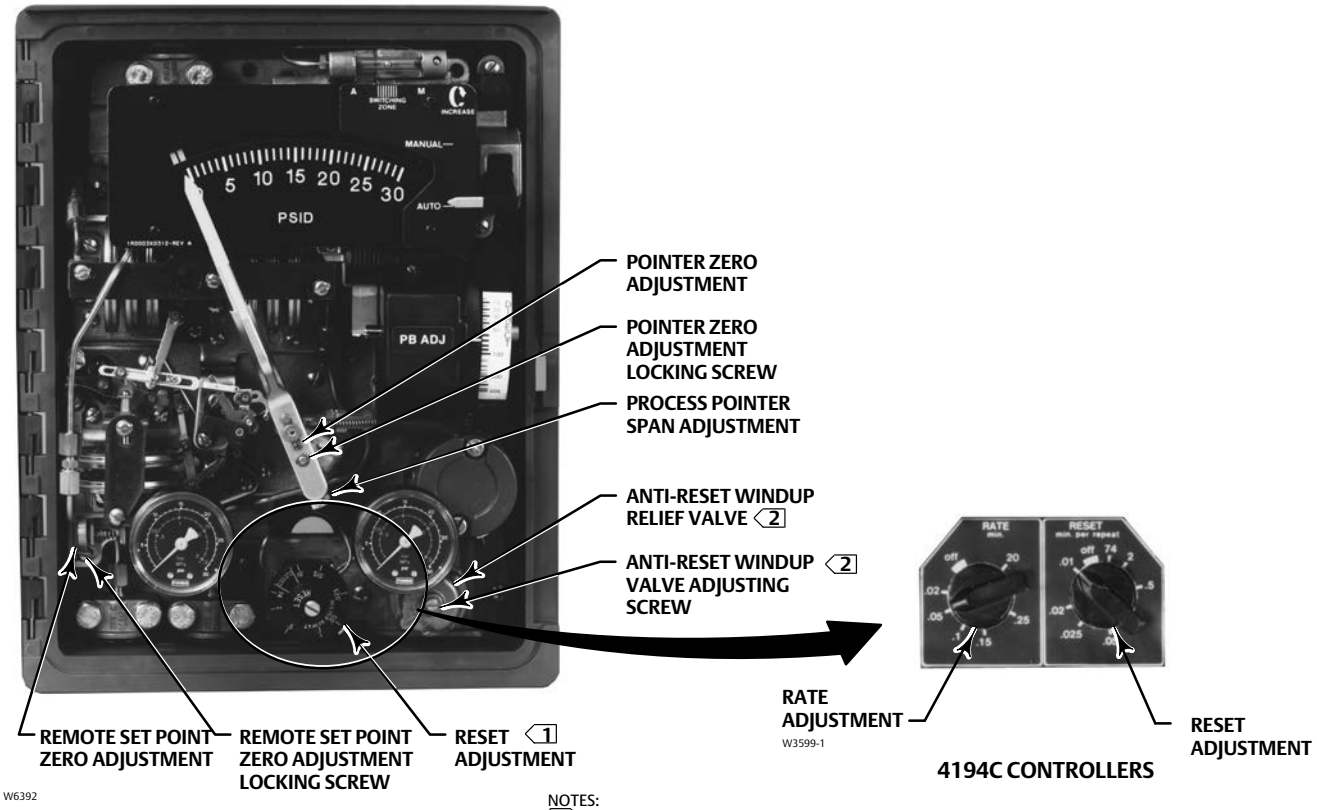
16. Apply process differential pressure equal to the mid-scale value of the process scale span. The process pointer should indicate mid-scale ±2 percent of the scale span. If the process pointer error is ±2 percent or less, proceed to step 17. If the process pointer error exceeds ±2 percent, the linearity can be improved with the linearity adjustment. See figure 5-17 for the linearity adjustment screw location.

    a. If the error at mid-scale is high (process pointer is to the right side of the mid-scale mark), loosen the linearity adjustment screw and slide it upward in the curved slot. Tighten the screw and return to step 6.

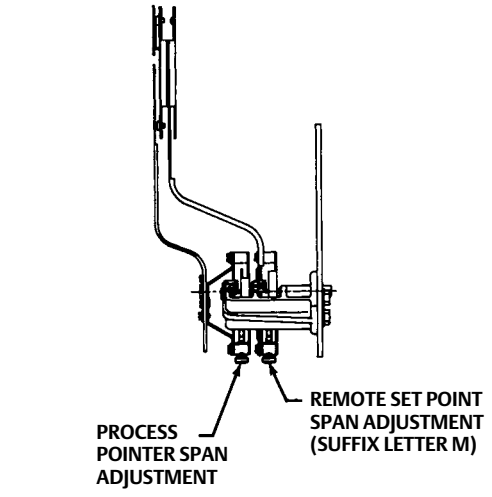
    b. If the error at mid-scale is low (process pointer is to the left side of the mid-scale mark), loosen the linearity adjustment screw and slide it downward in the curved slot. Tighten the screw and return to step 6.

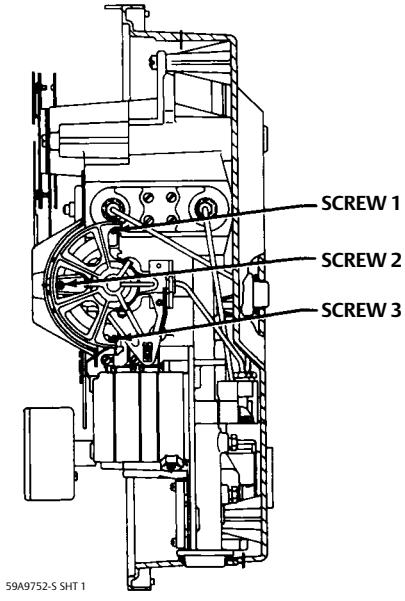
17. Adjust the process pointer to within ±1 percent of the mid-scale mark by loosening the zero adjustment locking screw and adjusting the zero adjustment screw. Tighten the zero adjustment locking screw. This distributes the error over the entire process scale and keeps all points within ±1 percent of the process scale span.

Figure 5-19. Fisher 4194 Controller Calibration Adjustment Locations



NOTES:
1 AVAILABLE ON 4194B CONTROLLERS ONLY.
2 AVAILABLE ON 4194B AND C CONTROLLERS SUFFIX LETTER F ONLY.


REMOTE SET POINT SPAN ADJUSTMENT (SUFFIX LETTER M)
PROCESS POINTER SPAN ADJUSTMENT
39A1126-B
A6731
SIDE VIEW OF SET POINT/ PROCESS INDICATOR ASSEMBLY



18. Adjust the process differential pressure to the lower and upper limits of the scale span to make sure the process pointer is still within ±1 percent of the lower and upper scale limits.
19. Perform the flapper alignment procedure and, if necessary, the appropriate remote set point calibration procedure in Section 3 or 4.

Remote Set Point (suffix letter M) Maintenance

Replacing the Remote Set Point Assembly

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Use the following procedures to replace the remote set point assembly. Figure 5-20 shows the parts locations. Refer to figure 6-5 for key number locations.

Note
Remove the supply pressure gauge before attempting to remove the remote set point assembly.

1. Decrease the remote set point pressure to 0 psig.
2. Remove the supply pressure gauge.
3. Remove the pressure connection (key 93) at the pedestal assembly (key 105). Use two 5/16 inch wrenches.
4. Disconnect link B (key 126) from the connection hole on the set point indicator.
5. Remove the three mounting screws (keys 120 and 140) that attach the remote set point assembly to the process/set point indicator assembly. Figure 5-20 shows the mounting screw locations.

CAUTION

In the following step, do not lift out the remote set point assembly by holding the capsular element or linkages. These parts may be damaged.

6. Lift out the remote set point assembly by holding the tie bar (key 106), mounting plate (key 111), travel stop (key 83), or pedestal assembly (key 105).
7. Align the replacement assembly with the mounting screw holes. Replace the mounting screws.
8. Reconnect the remote set point pressure connection union (key 93). Apply full remote set point pressure and check for leaks.
9. Connect link B (key 126) to the connecting hole on the set point indicator.
10. Replace the supply pressure gauge.
11. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedure in Section 3 or 4.

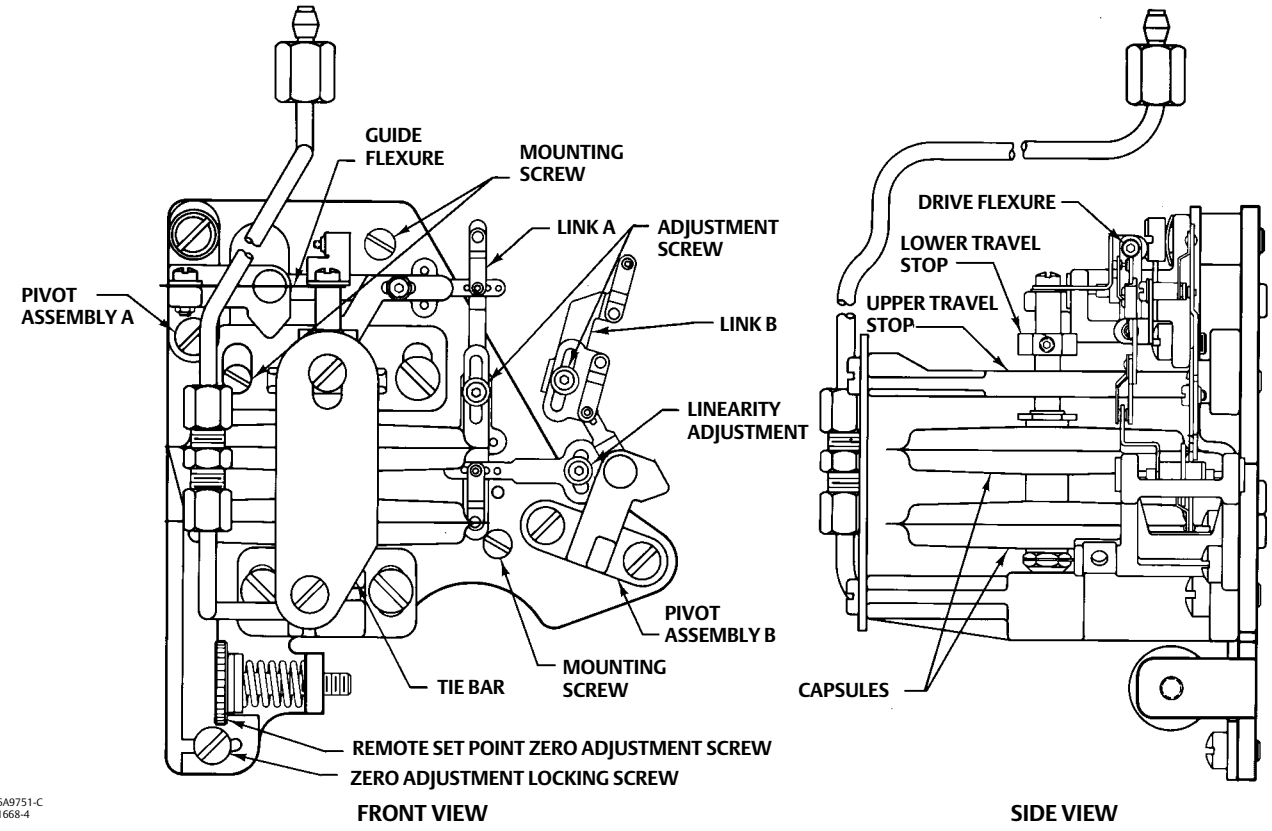
Replacing Remote Set Point Assembly Parts

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Figure 5-20 shows the parts and adjustment locations. Refer to figure 6-5 for key number locations.

Figure 5-20. Remote Set Point (suffix letter M) Parts and Adjustment Locations



Replacing Pivot Assembly A (Key 114)

CAUTION

Avoid bending or kinking the drive flexure during the following procedure. Bending or kinking the drive flexure can result in product damage and impaired performance.

1. Decrease the remote set point pressure to 0 psig.
2. Remove two screws (key 103) and remove the tie bar (key 106).
3. Note where link A is connected. Disconnect link A (key 116) from the lever arm on pivot assembly A (key 114).
4. Disconnect the drive flexure (key 79) from the adjustment arm of pivot assembly A. Be careful not to bend or kink the drive flexure.
5. Remove the screw (key 122), washer (key 123) and nut (key 124) that attach the guide flexure (key 119) to the top of the pivot assembly.
6. Remove the pivot screw and spring washer (keys 109 and 112) and the mounting screw (key 102) attaching the pivot assembly to the mounting plate (key 111). Lift out pivot assembly A.

7. Loosen the adjustment screw (key 118) on the adjustment arm of the replacement pivot assembly, and set the arm to the same length as the arm on the pivot assembly being replaced. Tighten the screw.
8. To replace the pivot assembly, first put the spring washer (key 112) on the screw (key 109). Then, insert the screw through the replacement pivot assembly and into the mounting plate and tighten. Install the mounting screw (key 102) and tighten.
9. Connect the guide flexure (key 119) to the top of the replacement pivot assembly with the screw (key 122), washer (key 123), and nut (key 124) as it was before. The guide flexure should be straight and horizontal as shown in figure 5-20. If not, loosen the screws (key 122) and retighten to eliminate any bowing. Loosen the screws (key 139) and raise or lower the pedestal assembly (key 105) to get the link horizontal. Retighten the screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.
10. Apply remote set point pressure equal to 50 percent of the remote set point input range.

Note

See figure 5-18. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.

11. Connect the drive flexure (key 79) to the arm on the replacement pivot assembly, making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the flexure is vertical. Before tightening the drive flexure screws, hold the pivot assembly shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold pivot assembly A in this position. Do not bend or twist the flexure when tightening the screws.
12. Decrease the remote set point pressure to 0 psig.
13. Connect the end of link A (key 116) to the pivot lever arm in the same holes noted in step 3.
14. Replace the tie bar (key 106).
15. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3 or 4.

Replacing Pivot Assembly B (Key 115)

1. Decrease the remote set point pressure to 0 psig.
2. Note the holes where links A and B are connected. Disconnect links A and B (keys 116 and 126) from the arms of pivot assembly B (key 115).
3. Remove the two screws (key 102) that attach pivot assembly B to the mounting plate (key 111). Remove the pivot assembly.
4. Loosen the linearity adjustment screw on the replacement pivot assembly, and set it in the same position as the adjustment on the original pivot assembly. Tighten the screw.
5. Set the replacement pivot assembly on the mounting plate, and attach it with the two machine screws.
6. Attach links A and B (keys 116 and 126) to the arms of the replacement pivot assembly in the same holes noted in step 2.
7. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3 or 4.

Replacing the Drive Flexure

1. Using an Allen wrench, remove the cap screws (key 12) and washers (key 13) to disconnect the drive flexure (key 79) from the drive bracket (key 121) and from the adjustment arm of pivot assembly A. Remove the drive flexure.

2. Set the remote set point pressure to 50 percent of the remote set point input range.

Note

See figure 5-18. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.

3. Connect the new drive flexure making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the drive flexure is straight. Before tightening the drive flexure screws, hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold the pivot shaft in this position. Do not bend or twist the flexure when tightening the screws.
4. Decrease the remote set point pressure to 0 psig.
5. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3 or 4.

Replacing the Remote Set Point Tubing

1. Decrease the remote set point pressure to 0 psig.
2. Using two 5/16-inch open-end wrenches, disconnect the pressure connection union (key 93) from the pedestal assembly (key 105) and the connection to the case exterior at the top of the case.
3. Remove the tubing (key 104).
4. Install the replacement tubing, and reconnect the two pressure connections.
5. Apply full remote set point pressure, and check for leaks.

Replacing Link A

This procedure describes link A (key 116) replacement in the input portion of the remote set point assembly. Figure 5-20 shows the link location.

1. Note the holes where link A is connected. Disconnect link A (key 116) from the lever arms on pivot assembly A and pivot assembly B.
2. Loosen the screw in the replacement link A and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 5-20 for the correct link orientation. Attach replacement link A to the two lever arms in the same holes noted in step 1.
4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3 or 4.

Replacing Link B

This procedure describes the link B (key 126) replacement of the remote set point assembly. Figure 5-20 shows the link location.

1. Note the holes where link B is connected. Disconnect link B (key 126) from the pivot arm and from the set point indicator.
2. Loosen the screw in the replacement link B and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 5-20 for the correct orientation of link B. Attach replacement link B to the pivot arm and to the set point indicator in the same position as noted in step 1.

4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in Section 3 or 4.

Remote Set Point (suffix letter M) Maintenance Calibration

Refer to figure 5-20 for parts and adjustment locations. Refer to figure 6-5 for key number locations.

Precalibration Procedures

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Remove the two screws (key 103) and remove the tie bar (key 106) from the remote set point assembly.

Aligning the Flexures

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Apply remote set point pressure input equal to 50 percent of the remote set point input range.
2. The guide flexure (key 119) should be straight and horizontal. If not, straighten the flexure by loosening the machine screw (key 122) on the end of the flexure that is attached to the top of pivot assembly A (key 114) and allow the flexure to straighten itself. Tighten the machine screw.
3. If the flexure is not horizontal, loosen the two machine screws (key 139) and raise or lower the pedestal assembly (key 105) until the guide flexure is horizontal. Retighten the machine screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.
4. The drive flexure (key 79) should be straight. If not, proceed as follows:
   a. Loosen the screw (key 118) on the adjustment arm of pivot assembly A (key 114) and loosen the screws holding the drive flexure.
   b. Set the length of the adjustment arm so that the drive flexure is parallel to the centerline of the diaphragm capsule assembly (key 80).
   c. Tighten the screw (key 118) on the adjustment arm.

Note

See figure 5-18. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings “float” inside the bearings and do not rest against the end of either bearing.

d. Hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing.

e. Tighten the screws that hold the drive flexure in place.

Setting the Travel Stops

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Loosen the set screw (key 87) in the travel stop nut (key 86).

CAUTION

Make sure the loose travel stop nut does not bind on the diaphragm capsule extension (key 134) when pressurizing the capsules (key 80). Damage to the capsules may result.

2. Full span stop—Adjust the remote set point pressure to 2-1/2 percent of span greater than the remote set point input range upper limit.

Loosen the two screws (keys 139 and 140) that secure the travel stop (key 83) to the mounting plate (key 111). Slide the travel stop until it is just touching the end of the capsule stack. Tighten the travel stop mounting screws to lock it into position.

3. Zero stop—Adjust the remote set point pressure input to 2-1/2 percent of span less than the remote set point input range lower limit.

Slide the travel stop nut (key 86), along the diaphragm capsule extension (key 134) until it is just touching the travel stop (key 83). Tighten the set screw (key 87) to lock the travel stop nut in position.

Aligning the Linkage

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

1. Adjust the remote set point pressure to 50 percent of the remote set point input range.
2. Set the linearity adjustment screw in the center of the slot on the lever arm of pivot clevis assembly B (key 115). See figure 5-20 for the linearity adjustment location.
3. Set the length of link A (key 116) so the lever arms of pivot assembly A and pivot assembly B are parallel and link A is perpendicular to them.
4. Set the length of link B (key 126) so the set point indicator indicates mid-scale on the process scale span.
5. Replace the tie bar (key 106) and install the two screws (key 103).

Remote Set Point Zero and Span Adjustment

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Note

For routine remote set point zero and span calibration, refer to the appropriate procedures in Section 3 or 4. Use the following maintenance remote set point zero and span adjustment procedure only if difficulty is encountered with the routine procedure or if nonlinearity occurs.

Refer to figures 5-19 and 5-20 for adjustment locations.

1. Decrease the remote set point pressure to 0 percent of remote set point input range.
2. The set point indicator should indicate the lower limit of the process scale span. If not, loosen the adjustment screw on link A (key 116), and adjust the length so that the set point indicator points to the lower limit of the process scale. Tighten the screw.
3. Make fine zero adjustments by loosening the zero adjustment locking screw (key 102) and turning the zero adjustment screw (key 108). Tighten the locking screw. Refer to figure 5-20 for the screw locations.
4. Apply a remote set point pressure equal to 100 percent of the remote set point input range.
5. The set point indicator should indicate the upper limit of the process scale span.
6. To increase the span, proceed as follows:
   a. Turn the remote set point span adjustment screw clockwise.
   b. To increase the span further than the adjustment screw allows, move both ends of link A (key 116) to the right.
   c. Make fine adjustments with the remote set point span adjustment screw.
7. To decrease the span, proceed as follows:
   a. Turn the remote set point span adjustment screw counterclockwise.
   b. To decrease the span further than the adjustment screw allows, move both ends of link A (key 116) to the left.
   c. Make fine adjustments with the remote set point span adjustment screw.
8. Repeat the adjustments until the upper and lower indications are aligned with the upper and lower limits on the process scale.
9. Adjust the remote set point pressure for 50 percent of the remote set point input range.
10. The set point indicator should indicate mid-scale ±2 percent of the process scale span. If the error is within ±2 percent, proceed to step 11. If the error is greater than ±2 percent of the scale span, proceed to the remote set point linearity adjustment procedure.
11. Adjust the set point indicator to mid-scale ±1 percent of the process scale span by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the locking screw.
12. Adjust the remote set point pressure to the upper and lower limits of the remote set point input range and make sure the set point indicator is still within ±1 percent of the lower and upper limits of the process scale.
13. Perform the appropriate flapper alignment procedure and, if necessary, the process indicator zero and span calibration procedure in Section 3 or 4.

Remote Set Point Linearity Adjustment

⚠ WARNING

Refer to the Maintenance WARNING on page 38.

Adjust the linearity by loosening and repositioning the linearity adjustment screw in the curved slot on the lever arm of pivot assembly B (key 115). Adjusting the linearity affects the zero and span adjustment.

1. Adjust the remote set point pressure to 50 percent of the remote set point input range. The set point indicator should indicate mid-scale ±1 percent of the process scale span. If not, make fine adjustments by loosening the zero adjustment locking screw and turning the zero adjustment screw.
2. Adjust the remote set point pressure to 0 percent of the remote set point input range and note the indicator position relative to the process scale lower limit.
3. Adjust the remote set point pressure to 100 percent of the remote set point input range and note the indicator position relative to the process scale upper limit.
4. If the greatest misalignment is positive (the set point indicator is to the right of the process scale limits), loosen the linearity screw and move it clockwise in the slot. If the misalignment is negative, move the linearity screw counterclockwise in the slot.
5. If misalignment is greater than 1 percent of the process scale span at the lower and upper limits, with one positive and the other negative, perform the remote set point zero and span adjustment procedure to correct a span error.
6. Repeat steps 1 through 4 until lower, middle, and upper indications are within ±1 percent of the process scale markings.

Auto/Manual Station (suffix letter E) Maintenance

Replacing the Auto/Manual Station

Refer to figures 6-1 and 6-6 for key number locations.

Note

This procedure also permits replacement of the switch manifold O-rings (key 312), the auto/manual tubing assembly (key 138), and the frame gaskets (keys 4 and 5).

Disassembly

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Loosen the screw (key 316) that holds the auto/manual station (key 273) to the controller frame.
3. Loosen the two screws (key 314 and 315) that hold the auto/manual station to the auto/manual tubing assembly (key 138).
4. Remove the auto/manual station from the controller frame.
5. Remove the switch manifold O-rings (key 312).

6. Carefully loosen the nut on the relay nozzle tubing assembly (key 18) where it connects to the auto/manual tubing assembly (key 138). Loosen three screws (keys 34 and 131), and remove the tubing assembly and frame gaskets (keys 4 and 5).
7. Inspect the gaskets (keys 4 and 5) and O-rings (key 312) for wear. Replace if necessary.

Assembly

1. Install the gaskets and the tubing assembly to the frame. Start, but do not tighten, the three screws (keys 34 and 131) and the nut on the relay nozzle tubing assembly (key 18).
2. Install the switch manifold O-rings (key 312), and secure the auto/manual station to the controller frame with the screw (key 316) and to the tubing assembly (key 138) with two screws (keys 314 and 315). Do not tighten any screws.

CAUTION

In the next step, take care to tighten the two screws (keys 314 and 315) evenly. Uneven tightening could damage the tubing assembly.

3. Position the auto/manual station as far down on the frame and toward the scale as possible. Carefully tighten the two screws (keys 314 and 315) so that the auto/manual station contacts the three pads on the tubing assembly.
4. Carefully tighten the remaining screws and nuts.
5. Plug the controller output connection and apply supply pressure to the controller. Check for leaks.
6. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
7. Perform the appropriate calibration procedure in Section 3 or 4.

Replacing the Switch Body Assembly, Lever O-Ring, Switch Body O-Ring and Tubing Assembly

Refer to figure 6-6 for key number location.

Disassembly

1. Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station Procedure.
2. Loosen the two screws (key 288), and remove the lever cover plate (key 305).

⚠ WARNING

The lever spring (key 302) is under preload. To avoid personal injury or parts loss, carefully disassemble the auto/manual station.

3. Using a 1.5 mm (1/16-inch) punch, push the groove pin (key 303) out toward the surface of the lever cover plate.
4. Remove the switch lever (key 304), lever spring (key 302), and lever spring seat (key 301).
5. Remove the tubing assembly (key 309).

⚠ WARNING

The switch body springs (key 295) are under preload. To avoid personal injury or parts loss, carefully separate the switch body assembly from the loader assembly.

6. Loosen the two screws (key 290), and separate the switch body assembly (key 291) from the loader assembly (key 282).
7. Remove the O-rings (keys 292, 293, and 294), switch body springs (key 295), and balls (key 296).
8. Loosen two screws (key 308), and remove the closing plate (key 307) and the closing plate gasket (key 306).
9. Pull the clip (key 300) from its engagement with the lever assembly shaft (key 297).
10. Pull the lever assembly from the switch body assembly (key 291) and rocker (key 299).
11. Remove the O-ring (key 298).
12. Inspect the O-rings and gaskets for damage or wear; replace if necessary.

Assembly

1. Insert the lever assembly (key 297) into the switch body assembly (key 291) and hold the rocker (key 299) with the flats on the lever assembly shaft.
2. Insert the clip (key 300) in the groove of the lever assembly shaft to hold the lever assembly (key 297) in the switch body assembly (key 291).
3. Position the closing plate gasket (key 306) and the closing plate (key 307). Secure with two screws (key 308).

Note
After assembly in step 3, be sure the side of the closing plate marked OUT is visible.

4. Place the balls (key 296), switch body springs (key 295), and O-rings (keys 292, 293, and 294) in the switch body assembly (key 291).

Note
In the following step, the ends of the springs must be in the counterbored spring seats before compression.

5. Compress the switch body springs with the loader assembly (key 282), and bolt the switch body assembly (key 291) to the loader assembly using the two screws (key 290).
6. Reconnect the tubing assembly (key 309).
7. Locate the lever spring (key 302) and the spring seat (key 301) on the switch lever (key 304), and position these parts in the opening of the loader assembly (key 282).
8. Push the switch lever down, using the lever spring seat (key 301) and the lever assembly (key 297) to preload the spring. Make sure the notch of the switch lever engages the pin of the lever assembly.
9. Drive in the groove pin (key 303) to hold the switch lever.
10. Replace the lever cover plate (key 305), and attach with two screws (key 288).
11. Perform the Assembly portion of the Replacing the Auto/Manual Station procedure.

Replacing the Loader Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball

Refer to figure 6-6 for key number location.

Disassembly

1. Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station procedure.

2. Remove the tubing assembly (key 309).

⚠ WARNING

To avoid personal injury caused by preload from the range spring (key 283), turn the loader knob (key 287) counterclockwise (opposite to the arrow) to relieve pressure on the spring.

3. Loosen the four screws (key 289), and separate the upper loader assembly (key 282) and the lower loader assembly (key 274).
4. Remove the loader range spring (key 283), range spring cup (key 284), and diaphragm assembly (key 281).
5. Remove the tube (key 278), ball seats (key 280) and ball (key 279).

Assembly

1. Turn the loader knob (key 287) counterclockwise to back the spring adjustment screw (key 285) all the way out to eliminate loading the range spring.
2. Position the range spring cup (key 284), the range spring (key 283), and the diaphragm assembly (key 281) on the upper loader assembly (key 282).
3. Position the ball (key 279), the tube (key 278), and the ball seats (key 280) between the ears of the loader assemblies (keys 282 and 274); position the diaphragm assembly (key 281) between the main halves of the loader assemblies.

Note

The tube (key 278) must be well seated in the cups of the ball seats (key 280).

4. Bolt the loader assembly halves together using the four screws (key 289).

Note

Be sure that the supply and exhaust seats of the loader are correctly aligned. Misalignment will impair loader performance.

5. Attach the tubing assembly (key 309).
6. Perform the Assembly portion of the replacing the Auto/Manual Station procedure.

Replacing the Loader Valve Plug and Valve Plug Spring

Refer to figure 6-6 for key number location.

1. Remove the controller assembly from the case by performing steps 1 through 3 of the case and cover replacement procedures.
2. Loosen the spring seat screw (key 275).
3. Remove the valve plug spring (key 276) and the valve plug (key 277).
4. Inspect the parts, and replace as necessary.
5. Install the valve plug spring and valve plug.

6. Tighten the spring seat screw.
7. Temporarily apply supply pressure and process differential pressure and check for leaks.
8. Position the controller assembly in the case and start, but do not tighten the nine mounting screws. Slide the controller assembly down to assure an O-ring seal at the pressure connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
9. Mount the controller as described in the Installation section.
10. Connect external piping to the controller.

Section 6

Parts

Parts Ordering

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the controller serial number. When ordering replacement parts, refer to the 11-character part number of each required part as found in the following parts list.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management, should not, under any circumstances, be used in any Fisher instrument. Use of components not supplied by Emerson Process Management may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury or property damage

Parts Kits

Description	Part Number
4190 Auto/Manual Repair Kit Contains keys 277, 278, 279, 281, 292, 293, 294, 298, 306, 312	R4190X0AM12
4190 Auto/Manual Retrofit Kit, SST tubing Contains keys 138, 273, 312, 313, 314, 315, 316	R4190X00S12
4190 Case Handle Kit Contains lever and mounting hardware	R4190X00H12
4190 Controller Repair Kit Contains keys 4, 5, 7, 8, 24, 52	R4190X00C12
4190 Pointer and Bracket Repair Kit Contains pointer and bracket ass'y, three machine screws, three washers	R4190X00P12
4190 Relay Replacement Kit Contains Relay Assembly, key 50	
0.2 to 1.0 bar (3 to 15 psig)	RRELAYX83C2
0.4 to 2.0 bar (6 to 30 psig)	RRELAYX83D2
4194BF Anti-Reset Windup Retrofit Kit, SST tubing, contains keys 44 and 55	R4190X00S22

Parts List

Abbreviations Used In The Parts List

adj:	adjustment
alt desgntn:	alternative designation
ass'y:	assembly
conn(s):	connection(s)
diff:	differential (as in process differential pressure)
fdback:	feedback
fill hd:	fillister head (as in fillister head cap screw)
frame:	controller frame (key 3)
ext:	external
hd:	head (as in machine screw head)
ind:	indicator
int:	internal
OD:	outside diameter
pl:	plated (as in plated steel)
prop:	proportional
pt:	point (as in set point)
qty:	quantity
SST:	stainless steel
w/:	with
w/o:	without

Controller Common Parts (figure 6-1)

Note

Figure 6-1 shows key numbers for the construction of 4194A, 4194B, and 4194C controllers. Figure 6-1 continues over several pages. Be sure to check all pages of figure 6-1 to find the key numbers.

Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

Key	Description	Part Number
1	Case and cover ass'y For use w/ or w/o int set pt and w/o remote or ext set pt For use w/remote set pt and w/o int or ext set pt	
2	Nameplate, A91100 (aluminum)	
3	Frame, A03600 (aluminum)	
4*	Gasket, chloroprene(1) for use between frame and frame manifold (key 135)	18A0749X012
5*	Gasket, chloroprene(1) 4194A and 4194B (1 req'd), 4194C (2 req'd)	18A0742X012
6	Machine screw, fill hd, 18-8 SST 2 req'd to mount the prop band ind cover to the frame 4 req'd to mount bellows bracket (key 31) to bellows beam (key 49) 2 req'd to attach process scale brackets (keys 376, 377) to frame	
7*	O-ring, nitrile(1) Used between frame and case at conns: low and high process diff pressure, output and supply pressure, and remote set pt conn 4 req'd w/o remote set pt 5 req'd w/remote set pt	1C376206992
8*	O-ring, nitrile(1) Used between frame and case on mounting bosses extending from the frame through the back of the case (3 req'd)	16A6903X012
9	Flexure pivot ass'y, sapphire/SST	
10	Machine screw, fill hd, 18-8 SST Used to attach the flexure pivot ass'y (key 9) to the frame (4 req'd)	
11*	Flapper ass'y	29A9518X012
12	Cap screw, hex socket, 18-8 SST For flapper ass'y (key 11) (2 req'd)	
17	Adjustable set pt pivot ass'y, SST	
18	Relay nozzle tubing ass'y, SST	
19	Machine screw, fill hd, 18-8 SST 1 req'd to attach adjustable set pt pivot ass'y (key 17) to frame For 4194C controllers 3 req'd to attach relay nozzle tubing ass'y (key 18) to frame	
20	Plain washer, 18-8 SST Used w/key 19 (2 req'd)	
21	Nozzle ass'y, SST	
22	Washer, plastic (2 req'd)	
23	Set pt beam ass'y, aluminum/SST	
24*	O-ring, nitrile(1) 1 req'd for nozzle tubing ass'y (key 18) 1 req'd for nozzle ass'y (key 21)	1E222606992
25	Proportional band knob, polycarbonate	
26	Retaining clip, S30200 (302 SST)	
27	E-ring, SST	
28	Set pt beam bias spring, pl steel	
29	Set pt beam shoe, G10100 (pl steel)	
30	Cap screw, hex socket, 18-8 SST Used w/key 29 (2 req'd)	
31	Bellows bracket, A95052 (aluminum)	
32	Bellows adj bracket, G10100 (pl steel)	
33	Bellows adj spring, pl steel	
34	Machine screw, fill hd, 18-8 SST used to attach frame manifold (key 135) to frame and for reset gain adjustment (2 req'd)	
35	Machine screw, hex hd, 18-8 SST Used to attach bellows bracket (key 31) to each bellows ass'y (key 48) (2 req'd)	
36	Proportional band indicator cover, ABS w/polyester label	
37	Self-tapping screw, 18-8 SST 4 req'd to attach process scale (key 61) to process scale bracket (key 376)	
38	Self-tapping screw, 18-8 SST Used to attach frame inside case (9 req'd)	
39	Supply gauge tubing ass'y, SST	
40	Proportional Tubing Ass'y (SST) For 4194A & B controllers For 4194C controllers	
41	Plug, S30300 (303 SST), For all 4194A & B controllers (1 req'd) For 4194C, CM, CE and CME (2 req'd) For 4194CF, CFM, CFE and CFME (1 req'd)	
42	Reset Valve Tubing Ass'y (4194B only) SST	
43	Reset Tubing Ass'y, SST For 4194B controllers For 4194C controllers	
44	Relief Tubing Ass'y, SST For 4194BF, BFM,BFE,and BFME only(3) For 4194CF, CFM, CFE, and CFME only	

Note

One type of pressure gauge is used for both output pressure and supply pressure indication. See Key 46/47 table for part numbers.

46*	Output gauge	See Key 46/47 table
47*	Supply gauge	See Key 46/47 table

*Recommended spare parts
1. This part is included in the 4190 Controller Repair Kit

Key 46/47* Pressure Gauge(2)

RANGE	GAUGE MATERIAL	
	Brass	SST
Dual Scale Gauge		
0 to 30psig/ 0 to 2 kg/cm^2	11B8577X042	11B8583X032
0 to 60 psig/ 0 to 4 kg/cm^2	11B8577X052	---
Triple Scale Gauge		
0 to 30psig/ 0 to 200 kPa/ 0 to 2 bar	11B8577X012	11B8583X012
0 to 60 psig/ 0 to 400 kPa/ 0 to 4 bar	11B8577X022	11B8583X022

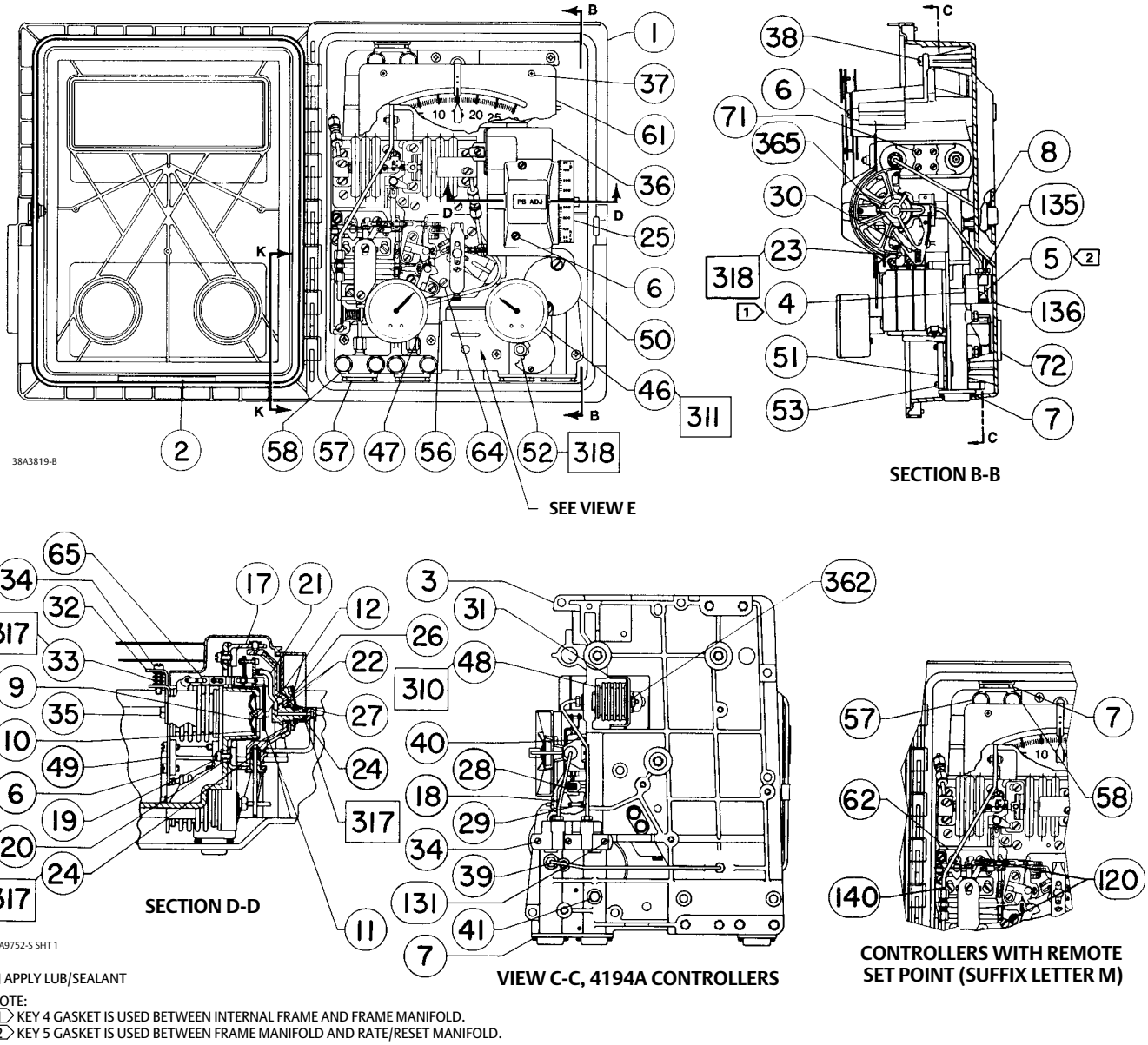
2. One type of pressure gauge is used for both output pressure and supply pressure indication.

Key	Description	Part Number
48*	Bellows ass'y (2 req'd)	
	Brass	16A6953X012
	S32100 (321 SST) / S30400 (304 SST)	16A6953X022
49	Bellows beam, A96061 (aluminum)	
	0.2 to 1.0 bar (3 to 15 psig	
	0.4 to 2.0 bar (6 to 30 psig)	
50	Relay Assembly	
	The relay assembly is included in the Replay Replacement kit	
	Relay, 0.2 to 1.0 bar (3 to 15 psig)	
	Relay, 0.4 to 2.0 bar (6 to 30 psig)	
51	Relief valve cover plate, A03600 (aluminum)	
52*	O-ring, nitrile(1)	
	Used w/key 51 (2 req'd)	1C853806992
53	Machine screw, fill hd, 18-8 SST	
	Used w/key 51 (2 req'd)	
54	Reset Restriction Valve (4194B controllers only)	
55	Differential Relief Valve	
	For all 4194B(3) and C controllers w/suffix letter F, anti-reset windup	
56	Process and set pt indicator ass'y w/capsular element ass'y for sensing of process diff pressure	
	Individual indicator ass'y parts are listed in three subsections of this parts list: the Process and Set Point Indicator Assembly (key 56) subsection, the Indicator Assembly (key 101) subsection, and the Capsular Element Ass'y (key 113) subsection. Key numbers for individual indicator parts also appear in figures 6-2 and 6-4.	
	Process and set pt indicator ass'y w/capsular element ass'y for sensing of process diff pressure plastic/aluminum/stainless steel	
57	Pressure control block, CF8M (316 SST Casting)	
	For internal process connections (2 req'd)	
	For external process connections (2 req'd)	
	For remote set point connection (internal)	
58	Cap screw, hex hd, SST	
	2 req'd for use w/each pressure control block (key 57)	
59	Hex reducing nipple, 1/2 NPT external (2 req'd) (Use only when specified)	
	Steel	
	SST	
60	Reducing adaptor, 1/2 NPT internal (2 req'd) (Use only when specified)	
	Steel	
	SST	
61	Process scale, aluminum for indicator ass'y (key 101)	
	0-5 psid	
	0-10 psid	
	0-15 psid	
	0-20 psid	
	0-30 psid	
	0-40 psid	
	0-50 psid	
	0-60 psid	
	0-75 psid	
	0-250 mbar differential	
	0-0.6 bar differential	
	0-1.4 bar differential	
	0-1.6 bar differential	
	0-2 bar differential	
	0-50 in. w.c. differential	
	0-5 psid	
	0-75 in. w.c. differential	
	0-100 in. w.c. differential	
	0-100 percent	
	0-10 square root	
	0-100 square root	
62	Remote set pt ass'y (suffix letter M)	
	Individual assembly parts for remote set pt (suffix letter M) are listed in the Remote Set Point Assembly subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 6-5.	
	Remote set pt ass'y (suffix letter M)	
	N09902 Nickel Alloy	
	0.8 bar (12 psig) span	
	1.7 bar (24 psig) span	
	SST	
	0.8 bar (12 psig) span	
	1.7 bar (24 psig) span	
64	Machine screw, fill hd,18-8 SST	
	4 req'd to attach process set pt and indicator ass'y (key 56/101) to frame	
65	Feedback link ass'y, aluminum/brass/SST	
71	Machine screw, fill hd, 18-8 SST	
	For all 4194A and B controllers (4 req'd)	
	For all 4194C controllers (6 req'd)	
72	Blowout plug	
120	Machine screw, fill hd, 18-8 SST	
	2 required to mount remote set pt ass'y (suffix letter M) to base plate of indicator ass'y (key 56/101)	
131	Machine screw, fill hd, S30400 (304 SST)	
	2 req'd to attach rate/reset manifold (key 136) to frame manifold (key 135)	

*Recommended spare parts

1. This part is included in the 4190 Controller Repair Kit
3. This part is included in the 4194BF Anti-Reset Windup Retrofit Kit

Figure 6-1. Controller Assembly Drawings

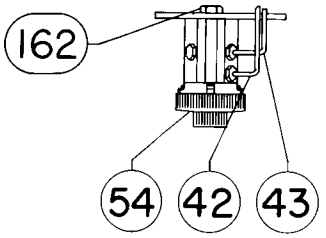


NOTE:
1 KEY 4 GASKET IS USED BETWEEN INTERNAL FRAME AND FRAME MANIFOLD.
2 KEY 5 GASKET IS USED BETWEEN FRAME MANIFOLD AND RATE/RESET MANIFOLD.

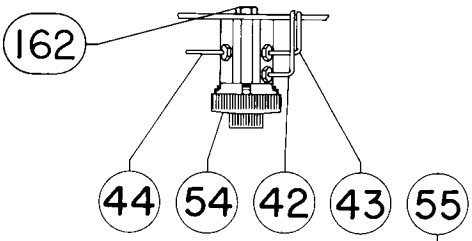
Key	Description
135	Frame manifold, A03600 (aluminum) For all types except w/suffix letter E, auto/manual station
136	Rate/reset manifold A03600 (aluminum) For all types except 4194C controllers
137	Rate Tubing Ass'y 4194C controllers only
138	Auto/manual tubing ass'y(4) Use w/suffix letter E, auto/manual station only SST/aluminum
140	Machine screw, fill hd, 18-8 SST Required to mount remote set pt ass'y (suffix letter M) to indicator ass'y
162	Machine screw, hex hd, 18-8 SST (For 4194B and C controllers only)

4. This part is included in the Auto/Manual Retrofit Kit

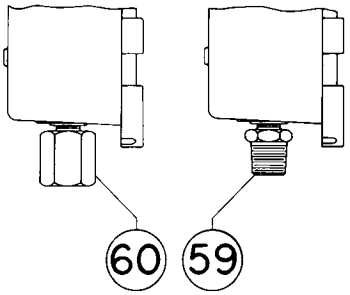
Figure 6-1. Controller Assembly Drawings (cont'd)



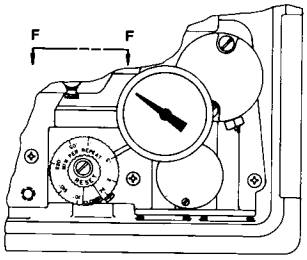
VIEW F-F



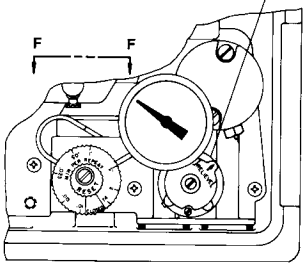
VIEW F-F



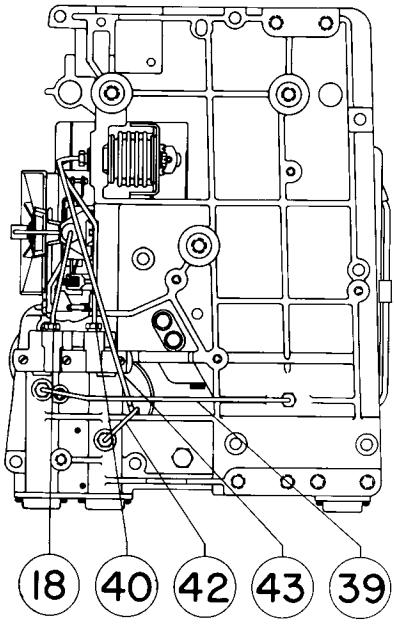
VIEW K-K
PROCESS CONNECTION ADAPTERS



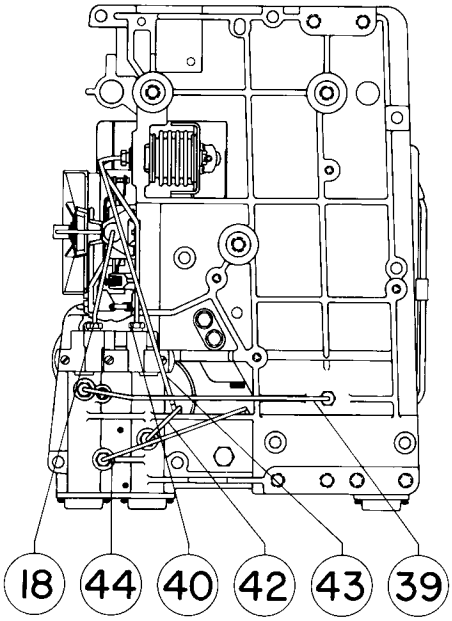
VIEW E, 4194B CONTROLLERS



VIEW E, 4194B CONTROLLERS,
WITH ANTI-RESET WINDUP
(SUFFIX LETTER F)



VIEW C-C, 4194B CONTROLLERS



VIEW C-C, 4194B CONTROLLERS,
WITH ANTI-RESET WINDUP
(SUFFIX LETTER F)

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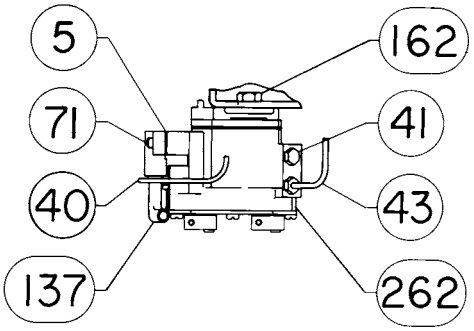
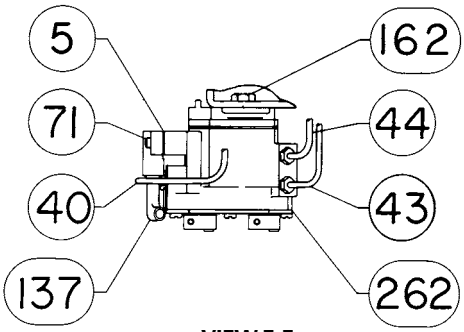
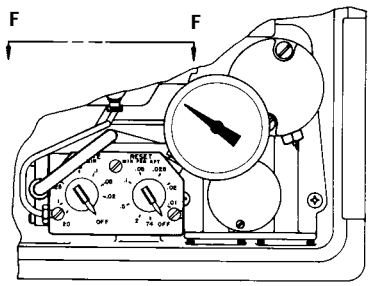
Figure 6-1. Controller Assembly Drawings (cont'd)



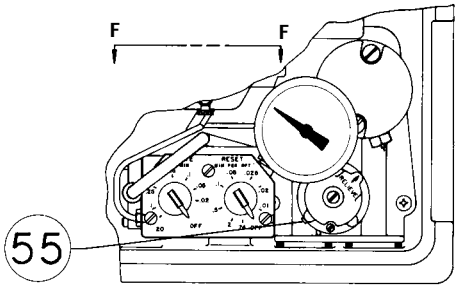
VIEW F-F



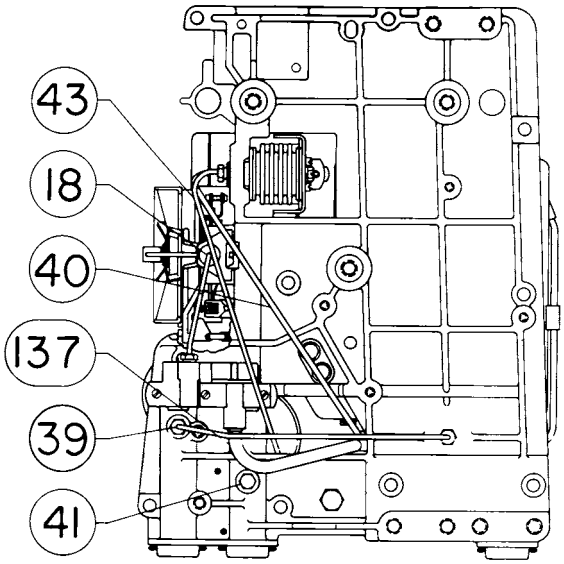
VIEW F-F



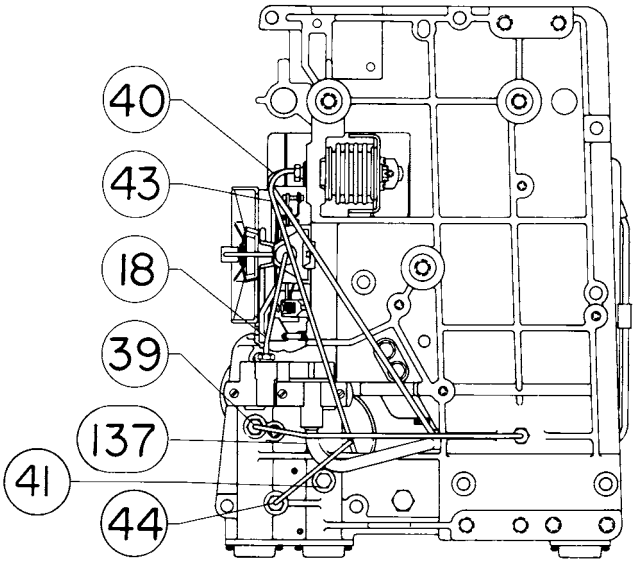
VIEW E, 4194C CONTROLLERS



VIEW E, 4194C CONTROLLERS, WITH ANTI-RESET WINDUP (SUFFIX LETTER F)



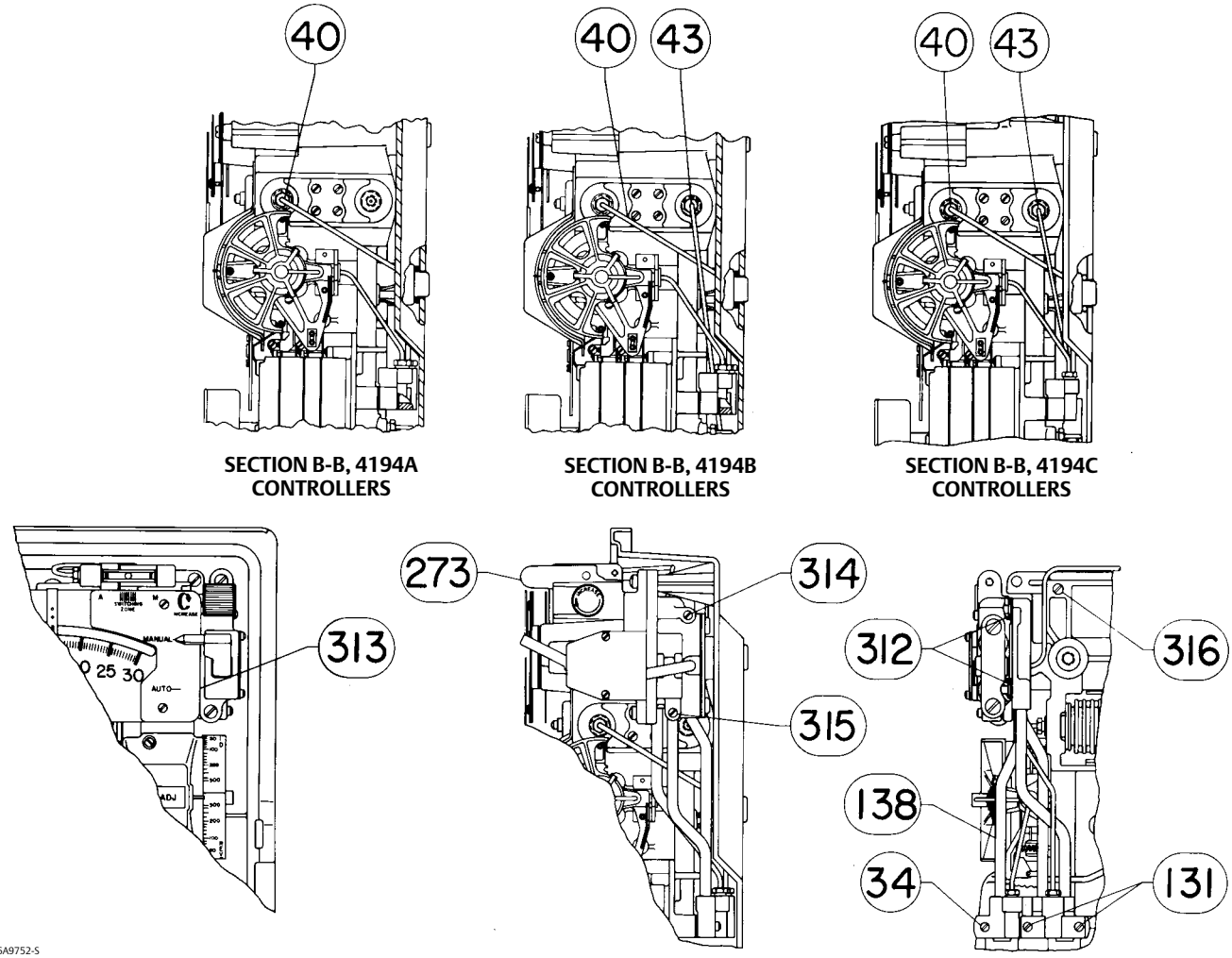
VIEW C-C, 4194C CONTROLLERS



VIEW C-C, 4194C CONTROLLERS, WITH ANTI-RESET WINDUP (SUFFIX LETTER F)

56A9752-S

Figure 6-1. Controller Assembly Drawings (cont'd)



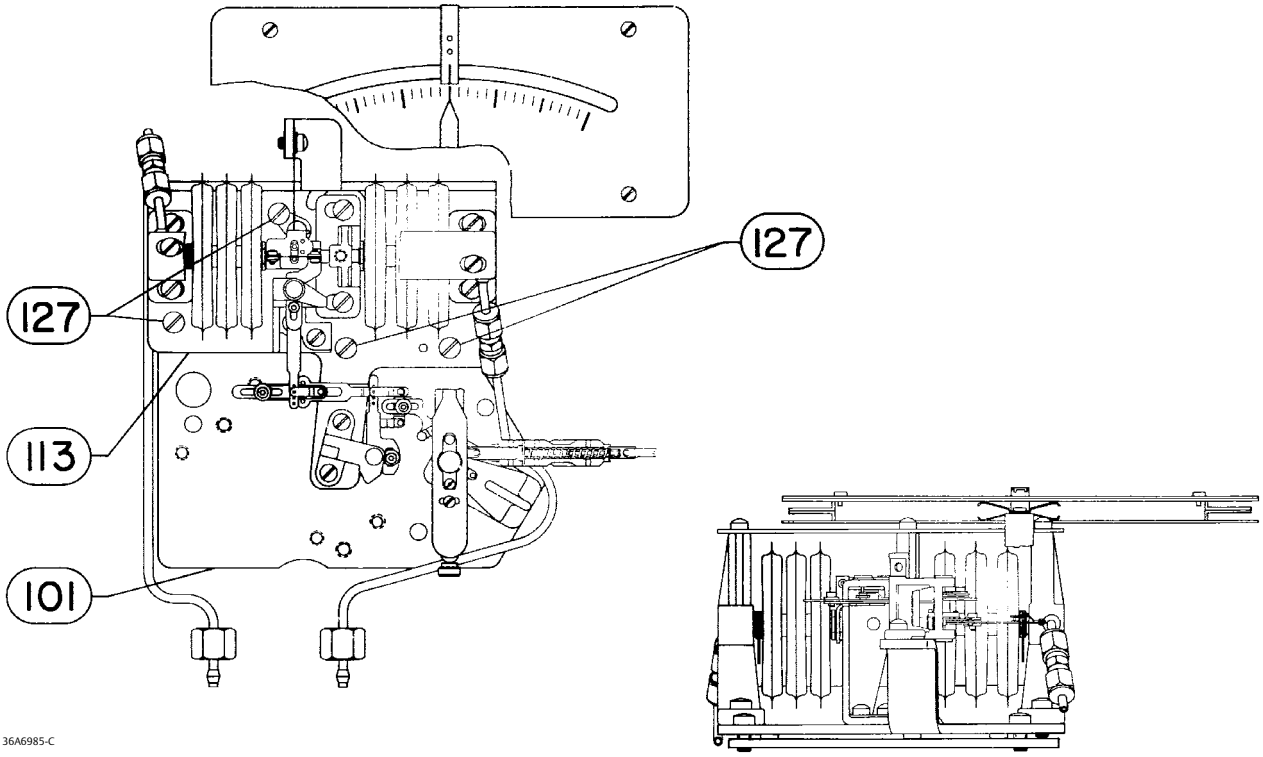
Key	Description	Part Number
262	Rate/reset valve ass'y (For 4194C controllers) Brass bellows 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig) SST bellows 0.2 to 1.0 bar (3 to 15 psig) 0.4 to 2.0 bar (6 to 30 psig)	
273	Auto/manual station (suffix letter E)(4) Individual assembly parts are listed in the Auto/Manual Station subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 6-6.	
310	Lithium grease (not furnished with controller)	
311	Anti-seize sealant, (not furnished with controller)	
312*	O-ring, nitrile (3 req'd)(4,5) For all types w/suffix letter E, auto/manual station	1P8453X0022

Key	Description
313	Auto/Manual scale, plastic(4) For all types w/suffix letter E, auto/manual station
314	Machine screw, fill hd, S30400 (304 SST)(4) For all types w/suffix letter E, auto/manual station
315	Machine screw, fill hd, 18-8 SST(4) For all types w/suffix letter E, auto/manual station
316	Machine screw, fill hd, 18-8 SST(4) For all types w/suffix letter E, auto/manual station
317	Silicone based lubricant, (not furnished with controller)
318	Lubricant, silicone sealant (not furnished with controller)
362	Spring retaining washer, SST
365	Washer, 18-8 SST

*Recommended spare parts

4. This part is included in the Auto/Manual Retrofit Kit
5. This part is included in the Auto/Manual Repair Kit

Figure 6-2. Process and Set Point Indicator Assembly



Key Description

Process and Set Point Indicator Assembly (key 56) (figure 6-2)

101 Indicator ass'y

Individual assembly parts are listed in the Indicator Assembly and the Capsular Element Assembly subsections of this parts list. Key numbers for individual assembly parts also appear in figures 5-23 and 5-24.

For use w/o remote set pt
For use w/remote set pt

113 Capsular element ass'y (for sensing of process diff pressure)

Individual assembly parts are listed in the Capsular Element Assembly subsection of this parts list. Key numbers for individual assembly parts also appear in figure 5-23.

Key Description

113 Capsular element ass'y (cont'd)

Capsular element assemblies are available in a wide variety of ranges and materials of construction. A few typical assemblies are listed here. Contact your Emerson Process Management sales office for assistance in the selection of specific parts.

N09902 Nickel Alloy
0 to 350 mbar (0 to 5 psid)
0 to 700 mbar (0 to 10 psid)
0 to 1.4 bar (0 to 20 psid)
0 to 2 bar (0 to 30 psid)

127 Machine screw, fill hd, 18-8 SST
For mounting capsular element ass'y to indicator ass'y (4 req'd)

Key	Description

Capsular Element Assembly (key 113) (figure 6-3)

Key	Description
12	Cap screw, hex socket, 18-8 SST (4 req'd)
13	Plain washer, 18-8 SST (2 req'd)
77	Mounting plate, G10100 (pl steel)
78	Long pivot clevis ass'y, plastic/SST
79	Drive flexure, S30200 (302 SST)
80	Diaphragm capsule ass'y (2 req'd) Diaphragm capsule ass'ies are available in a wide variety of ranges and materials of construction. A few typical ass'ies are listed here. Contact your Emerson Process Management sales office for assistance in the selection of specific parts. N09902 Nickel Alloy 0.15 bar (2.17 psig) span 0.7 bar (10 psig) span 1.4 bar (20 psig) span 2.1 bar (30 psig) span
81	Pedestal assembly, SST (2 req'd)
82	Diaphragm Ass'y Extension
83	Travel stop, CF8 (SST casting)
84	Drive bracket ass'y, SST
85	Follower bracket ass'y, SST
86	Travel stop nut, S30300 (303 SST)
87	Set screw, 18-8 SST
88	Connecting link ass'y, aluminum/bronze/brass
89	Short pivot clevis ass'y, plastic/SST
90	Connecting link ass'y, aluminum/bronze/brass
91	Process tubing ass'y, S30400 (304 SST) Connects the high pressure capsule ass'y to the high pressure input pressure control block (key 57)
92	Process tubing ass'y, S30400 (304 SST) Connects the low pressure capsule ass'y to the low pressure input pressure control block (key 57)
93	Union, S31600 (316 SST) (2 req'd)
97	Tie bar, G10100 (pl steel)
98	Machine screw, pan hd, 18-8 SST Used to attach the guide flexure (P/O drive bracket ass'y) to mounting plate
99	Plain washer, 18-8 SST
102	Machine screw, pan hd, 18-8 SST For mounting the short pivot clevis ass'y (key 89) and the long pivot clevis ass'y (key 78) to the mounting plate (key 77) (4 req'd)
103	Machine screw, pan hd, 18-8 SST For mounting tie bar (key 97) to pedestal ass'ies (key 81) and to travel stop (key 83) (3 req'd)
139	Machine screw, fill hd, 18-8 SST 2 req'd to mount each pedestal ass'y (key 81) 2 req'd to mount travel stop (key 83) Qty of 6 req'd

Figure 6-3. Capsular Element Assembly

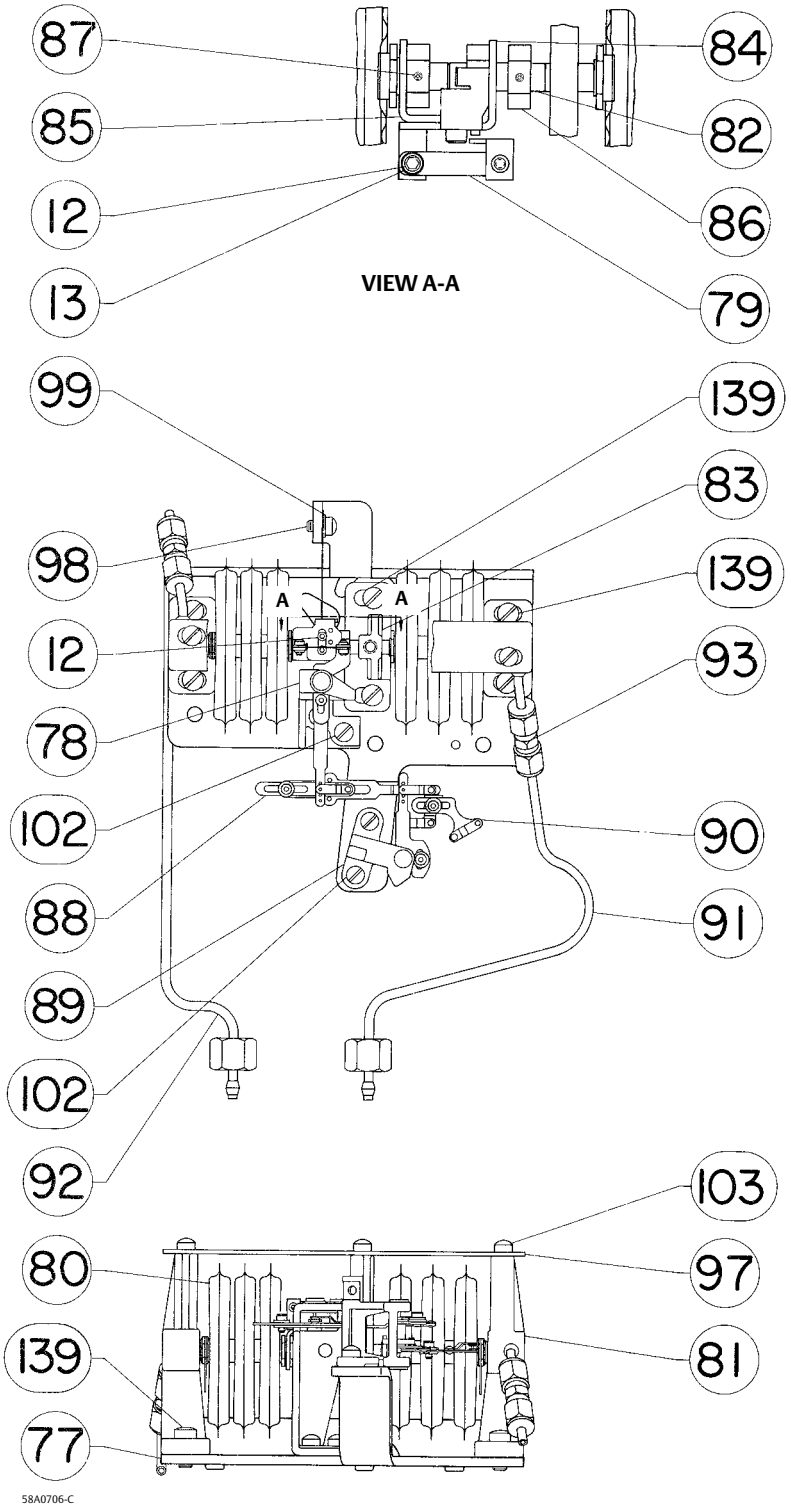
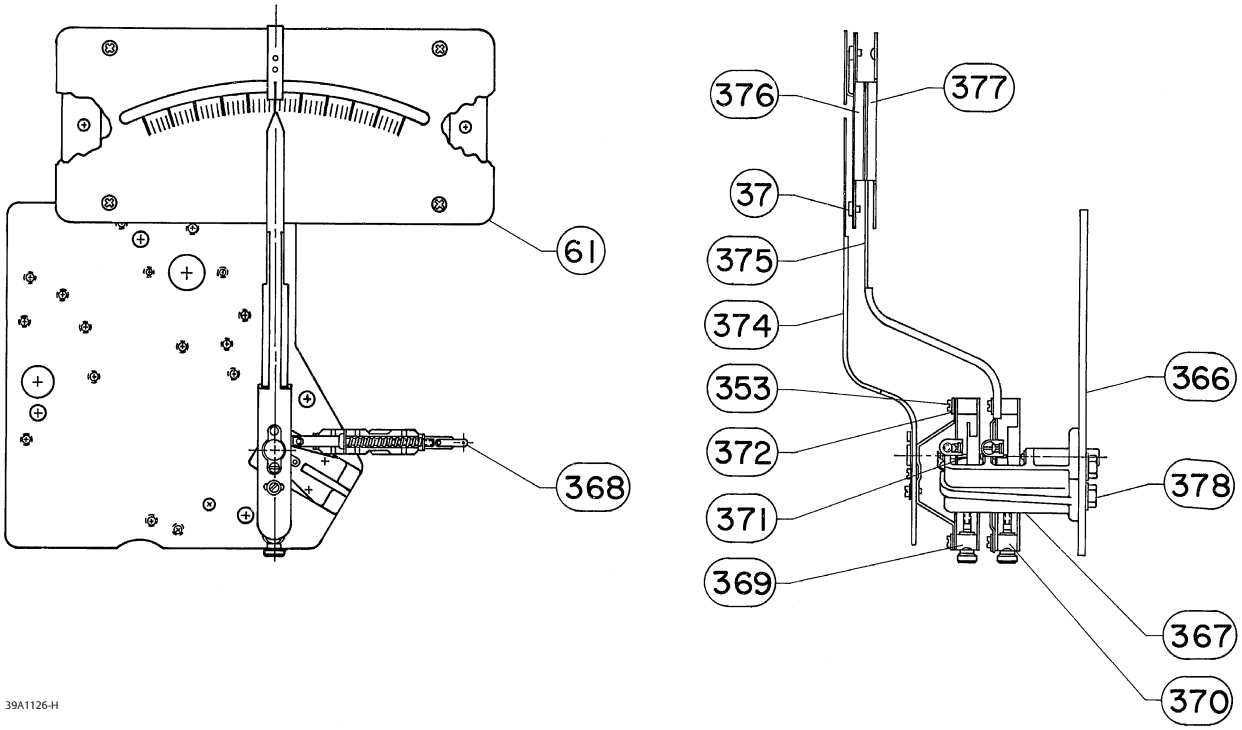


Figure 6-4. Indicator Assembly



Key Description

Indicator Assembly (key 101) (figure 6-4)

Note

Key numbers 37, 61, 376, 377, and 378 are not included as part of the indicator assembly (key 101). If replacing the indicator assembly and these parts are required, order them separately.

37 Self-tapping screw, 18-8 SST (4 req'd)
61 Process scale
353 Machine screw, pan hd. 18-8 SST (4 req'd)
366 Controller Mounting Plate, 18-8 SST

367 Support bracket ass'y, zinc/brass
368 Link ass'y, SST/brass (2 req'd)
369 Process pointer adj ass'y, aluminum/SST/brass

370 Set pt pointer adj ass'y aluminum/SST/brass
371 Pivot pin, 18-8 SST (2 req'd)
372 Washer, plain, 18-8 SST (4 req'd)
374 Pointer and bracket ass'y aluminum/steel
375 Set pt indicator ass'y, A93003 (aluminum)
for controllers w/remote set pt
for controllers w/o remote set pt

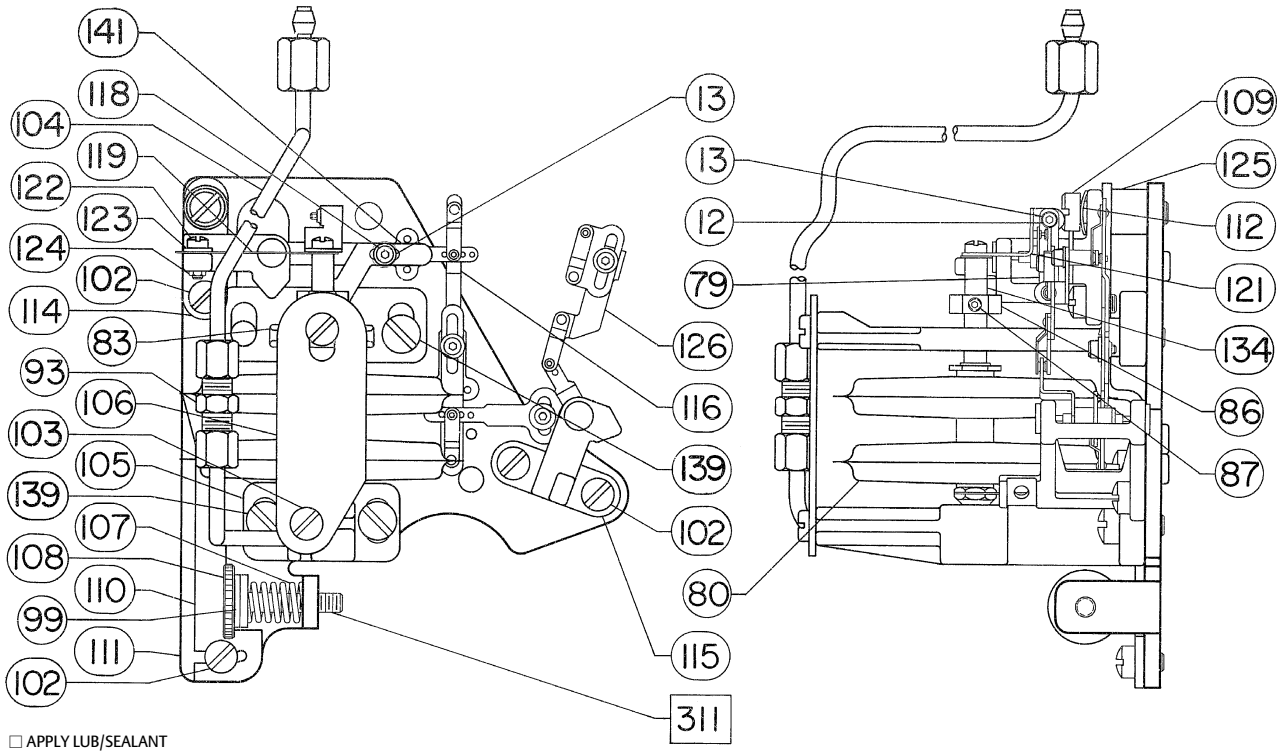
Key Description

376 Dial Bracket, G10080 (steel)
377 Dial bracket, G10080
378 Screw, self-tapping, 18-8 SST (2 req'd)

Remote Set Point Assembly (suffix letter M) (key 62) (figure 6-5)

12 Cap screw, hex socket, 18-8 SST
(2 req'd)2
13 Plain washer, 18-8 SST
(3 req'd)
79 Drive flexure, S30200 (302 SST)
80 Diaphragm capsule ass'y, for remote set pt ass'y
1 bar (12 psig) span
N09902 Nickel Alloy
SST
1.6 bar (24 psig) span
N09902 Nickel Alloy
SST
83 Travel stop, CF8 (SST casting)
86 Travel stop nut, S30300 (303 SST)
87 Set screw, hex socket, 18-8 SST
93 Union, S31600 (316 SST)
99 Plain washer, 18-8 SST
102 Machine screw, fill hd, 18-8 SST (4 req'd)
103 Machine screw, pan hd, 18-8 SST (2 req'd)
104 Remote set pt tubing ass'y,
S30400 (304 SST)

Figure 6-5. Remote Set Point Assembly Drawing



Key	Description
105	Pedestal ass'y, SST
106	Tie bar, G10100 (pl steel)
107	Spring, pl steel
108	Zero adj screw, S30300 (303 SST)
109	Pivot screw, S30300
110	Zero adj bracket, S30400 (304 SST)
111	Mounting plate, G10100 (pl steel)
112	Spring washer, pl steel
114	Pivot clevis ass'y A, plastic/SST
115	Pivot clevis ass'y B, plastic/SST
116	Connecting link ass'y, aluminum/bronze/brass
118	Cap screw, hex socket, 18-8 SST
119	Guide flexure, S30200 (302 SST)
121	Drive bracket, S30400 (304 SST)
122	Machine screw, fill hd, SST (2 req'd)
123	Plain washer, 18-8 SST
124	Nut, Hex, 18-8 SST
125	Spacer, A92011 (aluminum)
126	Connecting link ass'y, aluminum/bronze/brass
134	Diaphragm ass'y extension, A92011 (aluminum)
139	Machine screw, fill hd, 18-8 SST (3 req'd)
141	Adj arm, S30400 (304 SST)
311	Anti-seize sealant, (not furnished with controller)

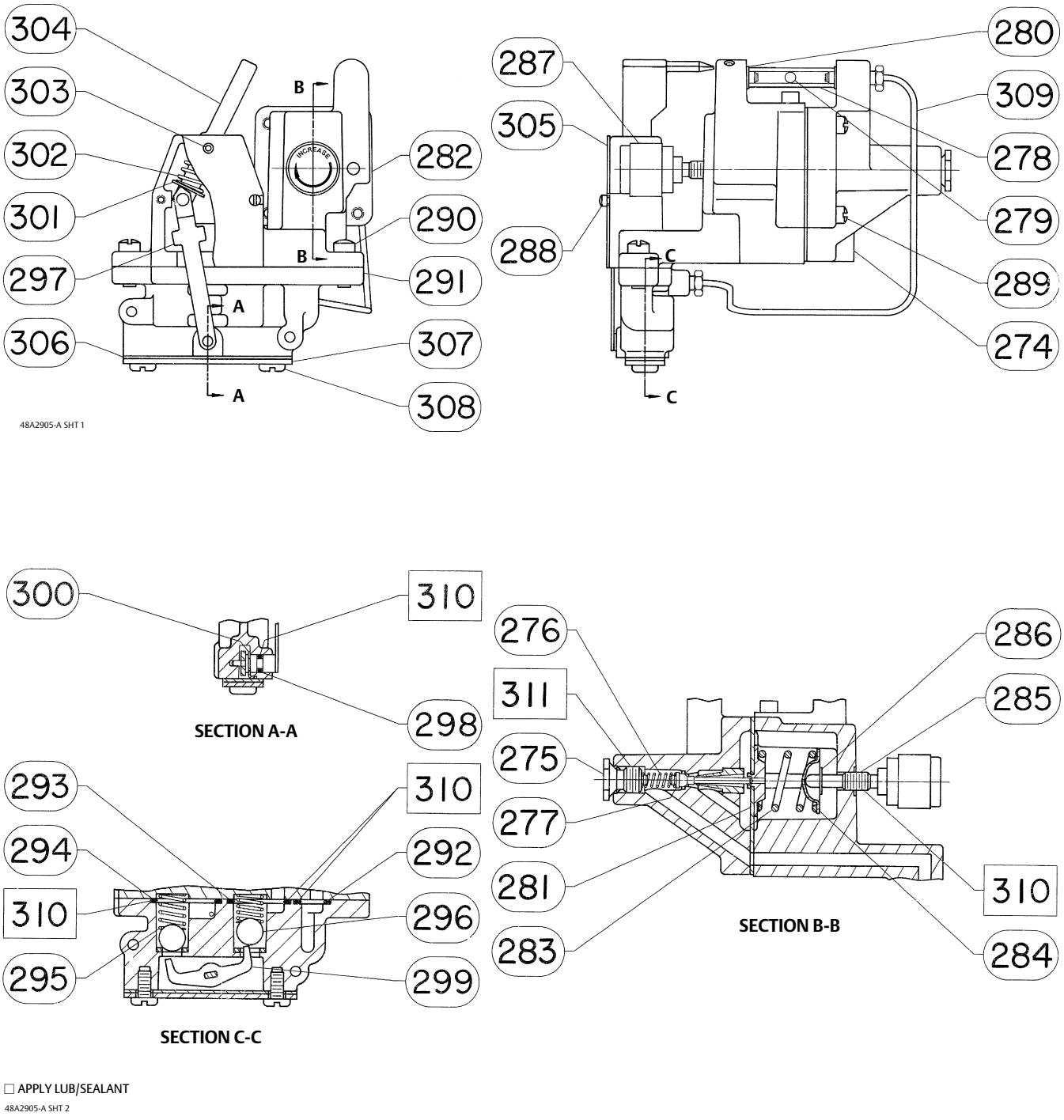
Auto/Manual Station (suffix letter E) (figure 6-6)

Key	Description	Part Number
274	Lower loader ass'y, aluminum	
275	Spring seat screw, pl steel	
276	Valve plug spring, A228 (“music wire”) alt desgntn: K08500 (pl steel)	
277*	Valve plug, 18-8 SST(5)	18A2878X012
278	Tube, plastic(5)	
279	Ball, SST(5)	
280	Ball seat, nitrile (2 req'd)	
281	Diaphragm ass'y, nitrile/aluminum(5)	
282	Loader ass'y, aluminum/plastic	
283	Range spring, SST	
284	Range spring cup, pl steel	
285	Spring adj screw, pl steel	
286*	Retaining ring, pl steel	18A2903X012
287	Loader knob, plastic	
288	Machine screw, rd hd, 18-8 SST (2 req'd)	
289	Machine screw, fill hd, 18-8 SST (4 req'd)	
290	Machine screw, fill hd, S30200 (302 SST) (2 req'd)	
291	Switch body ass'y, aluminum/nitrile	
292*	O-ring, nitrile(5)	1U2398X0032
293*	O-ring, nitrile(5)	11A8741X052
294*	O-ring, nitrile(5)	13A1584X012
295	Switch body spring, A228 (“music wire”) alt desgntn: K08500 (pl steel) (2 req'd)	
296	Ball, SST (2 req'd)	
297	Lever ass'y, SST	
298*	O-ring, nitrile(5)	1E2226X0032
299	Rocker arm, A96061 (aluminum)	
300	Clip, SST	
301	Lever spring seat, SST	
302	Lever spring, A228 (“music wire”) alt desgntn: K08500 (pl steel)	
303*	Groove pin, SST	16A6380X012
304	Switch lever, plastic/SST	
305	Switch lever cover plate, aluminum/chromate	
306*	Closing plate gasket, chloroprene(5)	18A2898X012
307	Closing plate, SST	
308	Machine screw, pan hd, 18-8 SST (2 req'd)	
309	Continuous output tubing ass'y, SST	
310	Lithium grease, (not furnished with controller)	
311	Anti-seize sealant, (not furnished with controller)	

*Recommended spare parts

5. This part is included in the Auto/Manual Repair Kit

Figure 6-6. Auto/Manual Station Assembly Drawing



Key Description

Controller Mounting Parts

Note
Contact your Emerson Process Management sales office for any additional parts required for controller mounting.

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

Pipestand Mounting (figure 2-2)

66 Cap screw, hex hd, pl steel (3 req'd)
67 Lock washer, pl steel (7 req'd)
68 Bracket, pl steel
69 Clamp, pl steel (2 req'd)

Pipestand Mounting with Regulator (figure 2-2)

66 Cap screw, hex hd, pl steel (3 req'd)
67 Lock washer, pl steel (7 req'd)
68 Bracket, pl steel
69 Clamp, pl steel (2 req'd)
362 Cap screw, hex hd, pl steel (2 req'd)
363 Lock washer, pl steel (2 req'd)
364 Hex nut, A563 pl steel (2 req'd)
365 Tubing fittings (2 req'd) See fittings subsection

Panel Mounting (figure 2-3)

66 Cap screw, hex hd, pl steel (3 req'd)
67 Lock washer, pl steel (3 req'd)
68 Bracket, A569 (pl steel)
70 Machine Screw, rd hd, pl steel (4 req'd)

Key Description

Wall Mounting (figure 2-4)

66 Cap screw, pl steel (3 req'd)
67 Lock washer, pl steel (3 req'd)
68 Bracket, pl steel

Controller Mounting Parts for Actuator With Casing-Mounted Controller

Spacer spool, steel (3 req'd)
Cap screw, hex hd, pl steel (3 req'd)
Lock washer, pl steel (5 req'd)
Mounting bracket, A569 (pl steel)
Cap screw, hex hd, pl steel (2 req'd)
Mounting bracket, G10100 (pl steel)
For 657/667 size 80 & 100
For all other types
Cap screw, hex hd, pl steel (2 req'd)
Hex nut, pl steel (2 req'd)
Washer, pl steel (2 req'd)
Washer, G10100 (2 req'd)

Controller Mounting Parts for Actuator With Yoke-Mounted Controller (figure 2-1)

Spacer spool, steel (3 req'd)
Cap screw, hex hd, pl steel (3 req'd)
Lock washer, pl steel (5 req'd)
Mounting bracket, steel
For 1061 w/switches or manual operator
For all other types
Spacer spool, steel (2 req'd)

Regulator Mounting Parts

Regulator Mounting Parts for Casing-Mounted Regulator

Cap screw, hex hd, pl steel (2 req'd)
Lock washer, pl steel (2 req'd)
Cap screw, hex hd, pl steel (2 req'd)
Hex nut, pl steel (2 req'd)
Mounting bracket, G10100 (pl steel)
For 657/667, size 80 & 100
For all other types

Key Description

Regulator Mounting Parts for Yoke-Mounted Regulator (Mounting Bracket Not Required)

Cap screw, hex hd, pl steel (2 req'd)
Lock washer, pl steel (2 req'd)

Regulator Mounting Parts for Yoke-Mounted Regulator (With Mounting Bracket)

Cap screw, hex hd, pl steel (2 req'd)
Lock washer, pl steel (4 req'd)
Cap screw, hex hd, pl steel (2 req'd)
Hex nut, pl steel (2 req'd)
Mounting bracket, G10100 (pl steel)
For 1061, size 30, all shaft sizes
For all other types

Description

Fittings

Fittings for 3/8-inch copper tubing, casing- or yoke-mounted controller with regulator
Connector, brass (2 req'd)
Elbow, brass (2 req'd)
Fittings for 3/8-inch copper tubing, pipestand-mounted controller with regulator
Elbow, brass (2 req'd)
Fittings for 3/8-inch copper tubing, all controllers without regulator
Connector, brass (1 req'd)
Elbow, brass (1 req'd)
Fittings for 1/2-inch synthetic rubber hose, all controllers with or w/o regulator
Connector, 316 SST
Elbow, 316 SST
Swivel, 316 SST (2 req'd)

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